



19 April 2006

Mr. Bob Boggs
California Department of Toxic Substances Control
700 Heinz Avenue, Suite 200
Berkeley, CA 94710-2721

**Subject: Preliminary Results of Subslab and Indoor Air Sampling and Field Sampling Plan
Addendum for an Additional Investigation at Building 937, dated April 2006
Presidio of San Francisco, California**

Dear Mr. Boggs:

The Presidio Trust ("Trust") implemented the first round of subslab soil vapor sampling and indoor air sampling at Building 937 at the Presidio in accordance with the *Field Sampling Plan for a Vapor Intrusion Assessment at Building 937, Presidio of San Francisco, California*, dated 13 October 2005 ("Building 937 FSP"). As reported to you in a letter dated 28 February 2006, the Trust recognizes that tetrachloroethene ("PCE"), detected at a maximum concentration of 5,970 micrograms per cubic meter ($\mu\text{g}/\text{m}^3$) in subslab vapor, exceeds the risk-based action level of 100 $\mu\text{g}/\text{m}^3$ for subslab vapor intrusion to indoor air.

The Trust has prepared the enclosed Addendum to the Building 937 FSP to investigate the source of PCE contamination detected in subslab soil vapor. In addition, preliminary results from the subslab soil vapor sampling and indoor air sampling at Building 937 are included in this submittal, because these data guide the rationale for the planned sampling. A full data report, including the data collected during this additional investigation, will be prepared after the data have been validated and the new data collected.

A draft data quality objectives ("DQOs") table and draft sampling location map were provided to you for comment at our meeting on 28 February 2006. The DQOs and sampling locations have been modified to incorporate suggested comments. However, the number of boring locations is approximately the same, as the Trust intends the results of this investigation provide sufficient data to characterize the site.

Enclosed for your review is the FSP Addendum. As discussed previously, the Trust has potential tenants for Buildings 933 and 937. Therefore, we hope you can expedite your review of this FSP Addendum to facilitate tenant occupancy.

Thank you for your help in this matter. Please call me at 415-561-4259 if you have questions.

Sincerely yours,
The Presidio Trust

A handwritten signature in cursive script that reads "Craig Cooper". The signature is written in dark ink and is positioned above the printed name and title.

Craig Cooper
Remediation Program Manager

Enclosure

Cc (with enclosure):

Brian Ullensvang, National Park Service (NPS)
Devender Narala, Regional Water Quality Control Board (RWQCB)
Doug Kern, Restoration Advisory Board (RAB)
Mark Youngkin, RAB

18 April 2006

Mr. Craig Cooper
The Presidio Trust
1750 Lincoln Boulevard
P.O. Box 29052
San Francisco, CA 94129-0052

**Subject: Preliminary Results of Subslab and Indoor Air Sampling and
Field Sampling Plan Addendum for an Additional Investigation at
Building 937
Presidio of San Francisco, California
EKI A000003.08**

Dear Mr. Cooper:

On behalf of the Presidio Trust ("Trust"), Erler & Kalinowski, Inc. ("EKI") has prepared this Field Sampling Plan Addendum ("FSP Addendum") to the Field Sampling Plan for a Vapor Intrusion Assessment for Building 937 at the Presidio of San Francisco dated 13 October 2005, including a 29 November 2005 response to comments letter (together the "October 2005 FSP"). The October 2005 FSP included subslab soil vapor and indoor air sample collection and analysis from various locations within Building 937. Building 937 is located within the Crissy Field Operable Unit and was addressed in the *Crissy Field Operable Unit 4 Implementation Report*, dated July 2004 (EKI, 2004). The subslab and indoor air sampling results were planned to be used to determine if mitigation measures are necessary to reduce potential risks to future building occupants.

EKI conducted subslab soil vapor sampling in December 2005, followed by indoor air sampling in January 2006, per the October 2005 FSP. The results of the subslab sampling event indicated the presence of benzene, chloroform, tetrachloroethene ("PCE"), and trichloroethene ("TCE") in subslab samples at concentrations above the risk-based target concentrations levels ("RBTCs"). The RBTCs were calculated in accordance with the procedures identified in the October 2005 FSP. The results of the indoor air sampling event indicated the presence of benzene and PCE in indoor air samples at concentrations above the indoor air RBTCs. This FSP Addendum summarizes the recently collected data and presents an approach to investigate the potential source of PCE and other volatile organic compounds ("VOCs") in the subsurface. Based on the subslab data, the second round of subslab and indoor air sampling proposed in the October 2005 FSP has been postponed until the results of this new field investigation can be evaluated.

EKI has prepared this FSP Addendum based on a request from the Trust to identify and evaluate the potential source(s) of VOCs detected in subslab vapor samples from below

Building 937. The initial request to evaluate the potential for subslab vapor intrusion came from an 8 August 2005 request by Mr. Robert Boggs of the California Environmental Protection Agency, Department of Toxic Substances Control ("DTSC"). The scope and objectives of this FSP Addendum build upon the results of the October 2005 FSP and were developed taking into account the DTSC vapor intrusion to indoor air guidance (DTSC, 2004), U.S. Environmental Protection Agency ("U.S. EPA") vapor intrusion to indoor air guidance (U.S. EPA, 2002), and consultation with the Trust, the National Park Service ("NPS"), DTSC, and Regional Water Quality Control Board, San Francisco Bay Region ("RWQCB"). This FSP Addendum incorporates input received at a 28 February 2006 meeting with DTSC, RWQCB, Trust, and NPS representatives where the draft Data Quality Objectives ("DQOs") and potential sampling locations were discussed. This FSP Addendum will be provided to the DTSC, RWQCB, and members of the Restoration Advisory Board ("RAB"). Collectively, these parties are referred to as the "stakeholders." The scope of work will be conducted in accordance with the Presidio-wide Quality Assurance Project Plan ("QAPP") (Tetra Tech, 2001).

1.0 BACKGROUND

Building 937 is located approximately 450 feet from the San Francisco Bay at the northern portion of the Presidio (see key map on Figure 1), with an interior building area of approximately 17,600 square feet. Generally, the building overlies fill. The depth to groundwater varies between approximately five and eight feet below ground surface.

The following is a summary overview of the remedial actions at Building 937, as documented in EKI's Crissy Field Implementation Report (EKI, 2004).

Historically, the Army operated a 500-gallon waste oil underground storage tank ("UST") and a 1,000-gallon xylenes UST (USTs 937.1 and 937.2, respectively) outside the northeastern corner of Building 937. In 1981, during the installation of a hydraulic lift and associated UST (UST 937.H) situated in the southeastern portion of Building 937, petroleum hydrocarbons were reportedly observed in soil. Between 1982 and 1984, the Army installed 22 groundwater monitoring wells in the vicinity of Building 937, which identified free product in wells closest to the Building 937 underground USTs (located on the northern side of the building), with measured thickness ranging between 6 and 36 inches. By 1990, the Army installed 9 additional groundwater monitoring wells in the Building 937 area. In 1992, the Army performed an Interim Remedial Action ("IRA"). This IRA included removal of the tanks and impacted soil as well as the installation of 3 additional groundwater monitoring wells in the Building 937 area. In May 1992, well points were installed upgradient and downgradient of the Building 937 UST area. No free product was observed in the well points. The locations of the three well points (937WP01, 937WP02, and 937WP04) inside the building are shown on Figure 1. Well point 937WP02 has been abandoned.

As part of the IRA, the two USTs 937.1 and 937.2 were removed along with approximately 500 cubic yards of soil. Part of this excavation was inside Building 937 but was limited to avoid structural damage to the building. Post-excavation verification soil samples were collected and petroleum-related constituents detected in the verification soil samples included total extractable hydrocarbons ("TEH") up to 4,500 milligrams per kilogram ("mg/kg") (937CS007), total volatile hydrocarbons ("TVH") up to 3,300 mg/kg (937CS033), xylenes up to 79 mg/kg, toluene up to 44 mg/kg, ethylbenzene up to 13 mg/kg, lead up to 260 mg/kg, and other volatile compounds such as acetone and chlorobenzene. These samples remained in place after the backfilling of the excavation. Benzene was not detected in the verification soil samples (Watkins-Johnson, 1993).

Between 1994 and 1998, a vacuum vaporization system (Unterdruck Verdampfer Brunnen ("UVB") system) operated to remove VOCs from the groundwater. A calculated mass of 4.8 to 17.6 kilograms of VOCs could have been removed by the UVB system from the subsurface during the first year of operation. The system operated continuously from August 1994 to September 1995, and intermittently between 1995 and 1998. The system ultimately was removed in 1998.

In 1998, the Army excavated soil from 2 locations on the north side of Building 937: outside the northwestern corner of Building 937 and outside the northeastern corner, adjacent to and within the footprint of the 1992 excavation. Chemical concentrations (including VOCs, polycyclic aromatic hydrocarbons ("PAHs"), metals, and petroleum hydrocarbons) in the sidewall verification soil samples from the northwestern corner of the building were less than the applicable cleanup levels in the Crissy Field Remedial Action Plan ("RAP"). PCE and TCE were detected in these sidewall confirmation samples at maximum concentrations of 0.037 mg/kg and 0.01 mg/kg, respectively.

For the second excavation in 1998, the Army excavated approximately 2,605 tons of soil from the northeastern corner outside of Building 937. Chemicals detected in the verification soil samples in the excavation wall at the 7.5-foot depth adjacent to Building 937 included total petroleum hydrocarbons as gasoline, diesel, and fuel oil ("TPHg, TPHd, TPHfo"), benzene, and toluene. Chemical concentrations were less than the applicable cleanup levels in the Crissy Field RAP in all verification samples, except for three samples collected adjacent to Building 937, which could not be removed due to the potential for structural damage to the building. Maximum residual concentrations in these sidewall samples included 7,600 mg/kg TPHg, 7,300 mg/kg TPHd, 21,000 mg/kg TPHfo, 73 mg/kg xylenes, 21 mg/kg toluene, and 13 mg/kg ethylbenzene. Chlorinated VOCs, such as PCE and its breakdown products, were not detected in the confirmation soil samples, although the detection limits were elevated due to the presence of petroleum hydrocarbon compounds (International Technology Corporation, 1998).

In December 2001, the Trust removed the hydraulic lifts from Building 937. Soil samples collected beneath the hydraulic fluid reservoir were analyzed for TPHg, TPHd,

TPHfo, benzene, toluene, ethylbenzene, xylenes, and PAHs. Only TPHd was detected at concentrations of 2.9 and 11 mg/kg (Treadwell & Rollo, 2003).

In May 2002, the Trust installed 3 soil borings to look for the presence of free-phase hydrocarbons in the smear zone and saturated zone at Building 937. Maximum concentrations detected include 8,200 mg/kg TPHg, 5,400 mg/kg TPHd, 18,000 mg/kg TPHfo, 5.1 mg/kg ethylbenzene, and 37 mg/kg xylenes. Toluene was not detected above the reporting limit of 3.4 mg/kg. No free-phase hydrocarbons were observed, and no VOCs were detected (Treadwell & Rollo, 2003).

In July 2004, EKI, on behalf of the Trust, prepared the Crissy Field Implementation Report (EKI, 2004) to document remedial actions at the Crissy Field sites and to request closure for the sites from the regulatory agencies.

Groundwater in the Building 937 Area has been monitored by the Army and the Trust since the early 1990s. However, the groundwater data are from areas outside the Building 937 footprint, from wells that were installed to monitor the hydrocarbon release and remediation described above. No groundwater data are available that would provide information about the source of VOCs in the subsurface vapor. The well points within Building 937 were monitored at one point for the presence of free product, which was not detected. The Trust has no analytical data for groundwater from the well points within the building.

As discussed below, it is possible that the source of VOCs may be located south of Building 937, at or near Building 933. Three groundwater monitoring wells were installed near Building 933 by the Army. Wells 937GW25 west of Building 933 and 937GW30 southwest of Building 933 were dry. Well 937GW21 was installed to the east of Building 933. No other investigations are known to have been conducted within the footprint of Building 933.

The Trust is planning to lease Buildings 937 and 933 to tenants for commercial use.

2.0 Preliminary Results of Subslab Vapor and Indoor Air Investigation at Building 937

In accordance with the October 2005 FSP, subsurface vapor samples were collected from Building 937 on 1 December 2005. As shown in Table 1, VOCs detected in the subsurface vapor include benzene, chloroform, PCE, 1,1,1-trichloroethane ("1,1,1-TCA"), TCE, 1,2,4-trimethylbenzene, toluene, and xylenes. The maximum concentrations of benzene, chloroform, PCE, and TCE exceeded their respective RBTCs for these chemicals with attenuation factors (" α ") of 0.1. Only PCE and TCE were detected in subsurface samples at concentrations that exceed the calculated RBTCs with an α of 0.01. PCE was detected at a maximum concentration of 5,970 micrograms per cubic meter (" $\mu\text{g}/\text{m}^3$ "), significantly greater than the RBTC of 10 (assuming $\alpha=0.1$). The data tabulated in Table 1 have not

completed the data validation process and are considered preliminary. The sample locations and the PCE concentrations detected in the subslab vapor are shown on Figure 1. The elevated concentrations of PCE in the subslab vapor were not anticipated, as PCE had not been identified as a chemical of concern at this site before. The source of the PCE is unknown.

In accordance with the October 2005 FSP, indoor and outdoor (ambient) air samples were collected and analyzed for the VOCs identified in the subslab vapor. Benzene was present in all samples (both indoor air and ambient air), at concentrations above the benzene RBTC of $0.22 \mu\text{g}/\text{m}^3$. PCE was also detected slightly above its RBTC in two indoor air samples, and slightly below its RBTC in one indoor and one outdoor air sample. The data from the indoor air sampling event are summarized in Table 2 (these data have also not completed the data validation process), and the sample locations are shown on Figure 1. The highest concentration of benzene was $2.42 \mu\text{g}/\text{m}^3$ at sample location 937IA102, near the floor drain. The floor drain was not flushed prior to sampling because it has been capped in-place. The data indicate that benzene is ubiquitous in the ambient and indoor air. The presence of benzene in the air does not appear to be correlated to subsurface impacts of benzene and PCE. The PCE concentrations detected in the sample and duplicate from location 937IA103, co-located with the highest subslab PCE concentrations, were both above and below the RBTC of $1.0 \mu\text{g}/\text{m}^3$.

As specified in the October 2005 FSP, another round of subslab and potentially indoor air sampling will be performed to evaluate whether seasonal variations modify the concentrations of the constituents. However, because the subslab sampling indicated that an unknown source of PCE may be present in the subsurface below Building 937, the Trust proposes to postpone the second round of indoor air sampling until the source of the PCE in the subslab vapor is better understood. A complete data report, including validated data from the subslab and indoor air sampling events, will be prepared upon completion of the work in this FSP Addendum.

3.0 DATA QUALITY OBJECTIVES

The data quality objectives ("DQOs") for this FSP Addendum are summarized in Table 3. The DQOs are designed to guide the collection of the additional data needed to evaluate the nature and extent of PCE and other VOCs in soil, soil gas, subslab vapor, and groundwater under or near Building 937. Since the Trust plans to lease Buildings 937 and 933 to commercial businesses, the source and extent of the VOC impact and any potentially significant human health risks should be identified prior to the leasing of the building. Once the source is identified, the potential risk to future recreational and commercial building occupants from exposure to residual subsurface chemicals through the vapor intrusion exposure pathway can be evaluated, and if deemed appropriate, monitoring or remedial measures evaluated and implemented. The DQOs identify the decisions that will be made in the investigation process.

As described in Table 3 and shown on Figure 2, a total of up to 15 new borings are proposed at Buildings 937 and 933 for soil gas, groundwater, and/or potential soil sampling. In addition, two additional subslab vapor locations are proposed. Soil gas samples will be collected from borings 937SB110 through 937SB118 and 933SB103 and analyzed using an onsite mobile laboratory to evaluate the data. Three of the boring locations (937SB119, 937SB120, and 937SB121) are considered contingent locations, and could be moved or eliminated if:

- Soil gas data collected during the investigation indicates that a revised placement of the borings could result in a better determination of the extent of VOCs below the building, or
- The mobile laboratory results do not indicate that the installation of these borings would provide additional information to determine the nature and extent of VOC impact in the subsurface.

EKI proposes to use residential and commercial/industrial California Human Health Screening Levels (“CHHLs”) as a means to identify where chemical concentrations in soil may be elevated, and, therefore, where soil samples should be collected. A copy of *Table 2 –California Human Health Screening Levels for Indoor Air and Soil Gas* from the CHHLs is included as Appendix A. As described in the DQO table (Table 3), if detected VOC concentrations in soil gas exceed residential CHHLs (even though the site is designated for recreational and commercial land use), a soil sample will be collected at that location. If detected VOC concentrations in soil gas exceed commercial/industrial CHHLs, up to 3 soil samples may also be collected from adjacent borings. The DQO table also specifies decision rules for comparing VOC concentrations in soil, groundwater, and subslab vapor samples with designated screening levels. The results of the sampling event will be used to evaluate the need for monitoring or potentially remedial actions.

In addition, up to 3 soil samples will be collected and analyzed for physical parameters to be used for vapor intrusion modeling (i.e., soil bulk density, soil grain density, total porosity, moisture content, total organic carbon content, and grain size distribution). Samples are anticipated to be collected from two borings in the north and central portion of Building 937, and one from within Building 933. The actual borings from which these physical parameter samples are collected will be determined in the field, and the actual samples will be selected to be representative of varied soil types observed below the base rock.

Table 4 is a matrix of planned sample locations that identifies which samples will be collected and the methods by which they will be analyzed.

4.0 FIELD ACTIVITIES

4.1 Pre-Field Activities

To prepare Buildings 937 and 933 for the environmental sampling described in this FSP Addendum, prior to field activities, the Trust will provide access to sampling locations, including removing any equipment that is currently located over and near planned sample locations. The Trust, NPS, and DTSC will select sampling locations in the field. The Trust will also provide utility clearance and contact Underground Service Alert prior to the initiation of subsurface work. EKI will update its site specific health and safety plan, and prepare subcontracts with the California licensed drilling contractors.

4.2 Sample Naming Conventions

In accordance with the QAPP, sample location identification codes are based on “937” or “933” for Building 937 or Building 933, respectively; “SB” for soil boring, “VS” for vapor sample, and “WP” for well point; and sequential numbering starting at 110 for Building 937 (as the Trust has some previous borings) and 101 for Building 933. Multiple samples could be collected from a single soil boring sample location (soil gas, soil, and/or grab groundwater); however, each sample of varying media from the same boring location will have the same sample location identifier. The media sampled will be marked on the chain of custody form and input into the media field in the Trust database when the data are uploaded. In keeping with the QAPP, a soil sample from 2 feet below ground surface will be designated as 937SB111[2]. If additional adjacent borings are required to comply with the DQOs to collect additional soil samples if the soil gas concentrations exceed the commercial/industrial CHHLs, the adjacent boring locations will be labeled with the next consecutive boring number that has not been assigned.

4.3 General Field Procedures for Collection of Soil Gas Samples

As described in the DQO table (Table 3), EKI will collect soil gas samples from up to 13 locations inside and outside Buildings 937 and 933, as indicated on Figure 2. Using direct push technology, EKI’s soil gas sampling contractor (currently planned to be TEG Environmental of Sacramento, California) will install temporary soil gas implants in accordance with the joint DTSC and the California Regional Water Quality Control Board – Los Angeles Region (“LARWQCB”) *Advisory – Active Soil Gas Investigations*, dated 28 January 2003 (DTSC and LARWQCB, 2003) (“State Advisory”), the procedures outlined in Appendix B, and Standard Operating Procedures (“SOP”) SOP 011, SOP 014, and SOP 015 of the Trust QAPP (included as part of Appendix B). Soil gas samples will be collected from approximately 5 feet below ground surface (“bgs”), at least 1 foot above local groundwater elevation measured in the well points in the building. The soil gas samples will be collected with gas-tight syringes and be analyzed by TEG in its onsite mobile laboratory. Temporary tubing to the implants will be removed after gas sample results have been analyzed and EKI determines that no

additional sample is needed to obtain analytical results that meet the project reporting limits. The soil gas investigation is anticipated to be completed in one day.

4.4 General Field Procedures for Collection of Grab Groundwater Samples

Following the soil gas investigation, grab groundwater samples will be collected from borings and well points as described in the DQO table (Table 3) and as indicated on Figure 2. Borings for grab groundwater (and potentially soil samples) will be located adjacent to the boring for the soil gas, ideally within one foot of each other.¹ Borings for grab groundwater samples will be drilled with direct push technology by EKI's drilling contractor (currently planned to be Precision Sampling of Richmond, California). Temporary well screens will be inserted into the boring to facilitate the collection of samples of the first encountered groundwater. EKI will collect grab groundwater samples in appropriate containers based on the planned sample analysis. Groundwater samples from the well points will be collected by low-flow sampling as specified in SOP 003. All groundwater samples will be handled in accordance with SOP 015, and equipment decontamination will be in accordance with SOP 014.

4.5 General Field Procedures for Collection of Soil Samples, If Required

As noted in the DQO table, if VOC concentrations in soil gas exceed the commercial/industrial CHHLs, soil samples are proposed from up to 3 adjacent borings. These borings will be located 5 to 10 feet from the primary boring location (i.e., the boring from which the soil gas sample exceeding the commercial/industrial CHHLs was collected), spread around the primary boring based on available soil gas data and other site features, but not more than half-way to any adjacent boring. If 3 or more soil gas samples exceed the commercial/industrial CHHLs, then the additional soil sampling approach will be discussed with the Trust, NPS, and DTSC.

Soil samples, if determined to be appropriate based on soil gas data and comparison with CHHLs, will be collected from borings installed by direct push technology. Soil sampling will be conducted in accordance with SOP 001, SOP 014, and SOP 015. The primary soil samples will be collected during drilling for the grab groundwater sample, as the results of the soil gas sampling will be known at that time. The extracted soil core will be screened with an organic vapor meter ("OVM") to identify the potential depth of greatest chemical impact. The soil sample from a core will be collected from the depth with the highest screening levels on the OVM; areas of noted discoloration, staining, or odor noted in the core; or from approximately 2 feet bgs if no specific area of impact can be readily identified.

At the request of a potential future Trust tenant, one soil sample will be collected from soil boring 933SB103 at 8 ft bgs or above the water table, whichever is shallower. This sample will be analyzed for VOCs, metals, and TPH.

¹ Both the grab groundwater and soil gas boreholes will have the same sample location identifier.

4.6 General Field Procedures for Collection of Subslab Soil Vapor Samples

As described in the DQO table (Table 3), EKI will collect subslab soil vapor samples at two sample locations at Building 933 in accordance with the field methods and procedures outlined in Appendix B and as specified in SOP 011, SOP 014, and SOP 015. Samples will be collected within two rooms in the building to assess whether VOCs are present in the subslab of Building 933. Proposed subslab soil vapor sampling locations are shown on Figure 2.

Subslab vapor samples will be collected in 6-liter SUMMA canisters and analyzed for the full scan of volatile organics with tentatively identified compounds ("TICs") by US EPA Method TO-15 for quantitative results. If detection limits for Method TO-15 are elevated above concentrations needed to calculate potential human health risks, samples will be analyzed using Method TO-15 with Selected Ion Monitoring ("SIM") to achieve detection limits to perform the risk calculations. Samples will be collected over approximately 20 minutes or as reasonable to fill the SUMMA canister. Specific field methods and procedures for subslab soil vapor sampling are included in Appendix B.

4.7 Field Quality Control Samples

One of the advantages of soil gas sampling and analysis with a mobile laboratory is the opportunity to perform the purge volume test, a field quality control test identified in the State Advisory (DTSC and LARWQCB, 2003). In addition, as the data are reported while the field team is still on site, questionable data can be re-sampled and analyzed prior to demobilization, thus reducing the chances of poor data quality due to field collection complications.

Field duplicates for soil gas, groundwater, and subslab vapor will be collected as part of this investigation. A field duplicate is a sample collected at the same time, and from the same source and depth as the associated primary sample. Field duplicate pairs are collected to assess the consistency or precision of the laboratory's analytical system. The QAPP specifies a frequency of ten percent for field duplicates. Therefore, two soil gas field duplicate samples will be collected in SUMMA canisters for offsite analysis at a fixed laboratory by US EPA Method TO-15 (this is greater than the State Advisory recommendation of 1 per day). Two grab groundwater field duplicates will be collected, and one subslab vapor field duplicate will be collected. Up to two duplicate soil samples will be collected, to achieve ten percent soil duplicates.

Trip blanks will be submitted to the laboratory for analysis for grab groundwater samples only.

4.8 Post-Sample Collection Activities

After completion of the soil sampling, a State of California-licensed land surveyor will survey the sampling locations. EKI has assumed that PLS Surveys, Inc. of Alameda, California will perform the surveying under the direction of EKI.

Wastes generated during the investigations at Buildings 933 and 937 will include concrete cuttings and cooling water used during concrete boring, pails of soil cores, decontamination water, groundwater purge water, as well as gloves and other personal protective equipment. Since neither cooling water nor concrete will have been in contact with contaminated soil, these wastes may be disposed as non-hazardous debris in regular trash. The soil cores, decontamination water, and groundwater purge water will require characterization before disposal. Personal protective equipment is anticipated to be disposed as non-hazardous waste with soil residuals. Disposal of all wastes will be the responsibility of the Trust.

5.0 LABORATORY ANALYSIS AND ANALYTICAL METHODS

The soil gas samples will be analyzed by TEG, Inc.'s mobile lab by EPA Method 8260. TEG indicates that the VOC detection limits of the instruments in their mobile laboratory can meet residential CHHLs, with the exception of benzene and vinyl chloride. The detection limits for these two compounds are slightly higher than the residential CHHLs, but below the commercial/industrial CHHLs. TEG's mobile laboratory does not provide data in Level III or Level IV data packages. Therefore, the data provided by TEG cannot be validated. The duplicate soil gas samples will be analyzed by K Prime of Santa Rosa, California, a State-certified analytical laboratory, on a standard two-week turnaround time. The duplicate soil gas samples will be analyzed by EPA Method TO-15, with SIM (if necessary to achieve detection limits to compare to CHHLs).

Groundwater samples, duplicate groundwater samples, and soil samples will be analyzed by STL San Francisco, of Pleasanton, California, a State-certified analytical laboratory, on a standard turnaround time. The groundwater and soil samples will be analyzed for VOCs by EPA Method 8260. Soil samples from 933SB103 will be analyzed for VOCs by EPA Method 8260, Title 22 Metals by EPA Method 6020, and total petroleum hydrocarbons by EPA Method 8015M (per the future tenant's request). STL San Francisco has indicated that sample analysis for metals by EPA Method 6020 will be performed by their sister laboratory, STL Sacramento.

Subslab vapor samples and a duplicate sample will be analyzed by K Prime of Santa Rosa, California, a State-certified analytical laboratory, on a standard turnaround time basis. The subslab samples will be analyzed by EPA Method TO-15, with SIM (if necessary to achieve detection limits to perform the risk calculation).

The analytical quality control criteria are provided in the QAPP. Analytical data from the fixed laboratories will be validated by DataVal, Inc. of Novato, California. As discussed

above, the data from the mobile laboratory cannot be validated because the data cannot be provided in Level III or Level IV data packages.

The analysis of physical properties for determining parameters for vapor intrusion modeling will be performed by PTS Laboratories of Santa Fe Springs, California. Analyses include soil bulk density (ASTM D2937), grain density (API RP40), total porosity (API RP40), moisture content (ASTM D2216), volumetric moisture content and volumetric air (API RP40), total organic carbon/fraction organic carbon (Walkley-Black method), and grain size distribution (ASTM D422M). The soil samples for physical properties will be collected from below the base rock from borings within buildings. The samples will be collected in 2-inch diameter sleeves.

6.0 SCHEDULE

EKI recognizes that the schedule of this sampling event is important to the Trust for leasing purposes. Field activities will commence upon stakeholder approval of this FSP Addendum. For planning purposes, EKI anticipates soil gas sampling will be performed approximately 31 May 2006, assuming stakeholder approval is obtained by 19 May 2006. It is anticipated that the soil gas sampling events can be completed in one day. Upon receipt of the mobile laboratory soil gas data, EKI will compare values to the CHHLs to determine if soil samples will be collected. Following the soil gas sampling, subslab vapor sampling and grab groundwater sampling will commence. If necessary, soil sampling will be performed at the same time as the drilling for the grab groundwater samples. EKI estimates all field activities can be performed within one week, assuming subcontractors are available at that time.

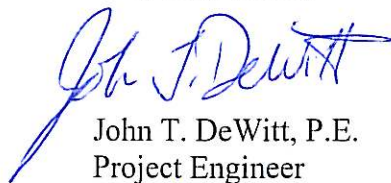
Upon receipt of the laboratory data, EKI will review the data and calculate potential human health risks. EKI will provide the Trust and NPS with a summary of the data and potential health risks within two weeks of the receipt of the laboratory data.

A final sampling report will be prepared in conjunction with the subslab vapor sampling and indoor air sampling data collected under the October 2005 FSP.

Letter to Mr. Craig Cooper
Building 937 Field Sampling Plan
18 April 2006
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Please contact us at (650) 292-9100 if you have any questions or comments.

Very truly yours,



John T. DeWitt, P.E.
Project Engineer



Michelle K. King, Ph.D.
Project Manager

Attachments

Table 1 – Volatile Organic Compounds Detected in Subslab Vapor, Building 937
Table 2 – Volatile Organic Compounds Detected in Indoor Air, Building 937
Table 3 – Data Quality Objectives, Building 937 Vapor Intrusion Study Addendum
Table 4 – Sample Laboratory Analysis Matrix, Building 937 Vapor Intrusion Study Addendum

Figure 1 – Building 937 PCE Concentrations in Subslab Vapor and Air Sampling Locations

Figure 2 – Building 937 Existing and Proposed Sampling Locations

Appendix A – Table 2 – California Human Health Screening Levels for Indoor Air and Soil Gas from the California Environmental Protection Agency
California Human Health Screening Levels

Appendix B – Field Methods and Procedures for Subslab Soil Vapor Sampling

References

California Environmental Protection Agency, 2005. *Use of California Human Health Screening Levels (CHHLs) in Evaluation of Contaminated Properties*. January 2005.

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US EPA, 2002. *OSWER Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance).* November.

Watkins-Johnson, 1993. *Soil and Groundwater Pollution Characterization Report for Building 937, Presidio of San Francisco.* September.

Table 1
Volatile Organic Compounds Detected in Subslab Vapor
 Building 937
 Presidio of San Francisco, San Francisco, California

Sample ID (a)	Concentration (µg/m ³)							
	Benzene	Chloroform	Tetrachloroethene	1,1,1-Trichloroethane	Trichloroethene	1,2,4-Trimethylbenzene	Toluene	Xylene (m,p-)
937VS101	3.87	<4.88	17.2	<5.46	8.38	5.70	5.61	8.73
937VS102	<3.19	<4.88	<6.78	<5.46	<5.37	<4.92	<3.77	<4.34
937VS103	<3.19	<4.88	43.8	<5.46	<5.37	<4.92	3.81	7.60
937VS104	<6.39	<9.77	450	125	<10.7	<9.83	<7.54	<8.68
937VS105	<31.9	<48.8	2,890	<54.6	1,190	<49.2	<37.7	<43.4
937VS106	<6.39	<9.77	474	60.9	<10.7	<9.83	<7.54	<8.68
937VS107	<63.9	<97.7	5,790	<109	<107	<98.3	<75.4	<86.8
937VS107 DUP	<63.9	<97.7	5,970	<109	<107	<98.3	<75.4	<86.8
937VS108	<3.19	<4.88	154	19.9	16.3	9.54	<3.77	6.95
937VS109	<3.19	12.4	154	<5.46	12.0	<4.92	<3.77	5.56
Sub-slab RBTC ($\alpha=0.1$) (b)	2.2	12	10	21,000	31	120	6,300	15,000
Sub-slab RBTC ($\alpha=0.01$) (c)	22	115	100	210,000	310	1,200	63,000	150,000

Notes

- (a) All samples collected on 1 December 2005 and analyzed by K Prime using EPA Method TO-15. Table only shows detected compounds.
 (b) Detected concentrations exceeding the site-specific RBTC when $\alpha=0.1$ are shown in bold. Equations used to calculate RBTC were presented in the October 2005 Field Sampling Plan. Derivation of RBTC values will be presented in the upcoming data report.
 (c) Detected concentrations exceeding the site-specific RBTC when $\alpha=0.01$ are shown in bold and underlined.
 (d) Data presented have not been validated and are considered draft.

Abbreviations

RBTC: Risk-based Target Concentration

µg/m³: micrograms per cubic meter

α : sub-slab vapor to indoor air attenuation factor

Table 2
Volatile Organic Compounds Detected in Indoor Air
 Building 937
 Presidio of San Francisco, San Francisco, California

Sample ID (a)	Location	Concentration (µg/m³)								
		Benzene	Chloroform	Tetrachloroethene	1,1,1-Trichloroethane	Trichloroethene	1,2,4-Trimethylbenzene	Toluene	Xylene (m,p-)	Xylene (o)
937IA101	indoor	1.26	<0.980	<0.680	<5.46	<2.15	<4.92	<3.77	<4.34	<4.34
937IA102	indoor	2.42	<0.980	1.01	<5.46	<2.15	<4.92	<3.77	<4.34	<4.34
937IA103	indoor	1.41	<0.980	0.690	<5.46	<2.15	<4.92	<3.77	<4.34	<4.34
937IA103 DUP	indoor	1.37	<0.980	1.06	<5.46	<2.15	<4.92	<3.77	<4.34	<4.34
937IA104	indoor	1.26	<0.980	<0.680	<5.46	<2.15	<4.92	<3.77	<4.34	<4.34
937IA105	outdoor	1.39	<0.980	0.790	<5.46	<2.15	<4.92	<3.77	<4.34	<4.34
937IA106	outdoor	1.32	<0.980	<0.680	<5.46	<2.15	<4.92	<3.77	<4.34	<4.34
Indoor Air RBTC (b)		0.22	1.2	1.0	2,100	3.1	12	630	1,500	1,500

Notes

- (a) All samples collected on 31 January 2006 and analyzed by K. Prime using EPA Method TO-15. Samples were only tested for compounds detected in sub-slab soil vapor samples collected on 1 December 2005.
- (b) Detected concentrations exceeding the site-specific RBTC are shown in bold. Equations used to calculate RBTC were presented in the October 2005 Field Sampling Plan. Derivation of RBTC values will be presented in the upcoming data report.
- (c) Data presented have not been validated and are considered draft.

Abbreviations

RBTC: Risk-based Target Concentration
 µg/m³: micrograms per cubic meter

TABLE 3 - DATA QUALITY OBJECTIVES
BUILDING 937 VAPOR INTRUSION STUDY ADDENDUM
Presidio of San Francisco, California

State the Problem	Identify the Decisions	Identify Inputs to the Decisions	Define the Study Boundaries	Develop Decision Rules	Specify Limits on Decision Errors	Optimize the Design
Concentrations of tetrachloroethene (“PCE”) above site-specific risk-based action levels have been found in subslab vapor samples collected below Building 937. Trichloroethene (“TCE”) has also been found in one subslab vapor sample above action levels. While Building 937 was previously believed to contain residual petroleum hydrocarbon contamination and potentially chlorinated solvents in the former tank area, the observed PCE and TCE concentrations in the subslab vapor are highest outside of the area of suspected petroleum hydrocarbon impact. PCE has been detected below maximum contaminant levels (“MCLs”) in both historical and on-going groundwater monitoring in the Building 900s Area. TCE has been detected above the MCL in on-going groundwater monitoring in the Building 900s Area. There are insufficient groundwater chemical data from the immediate area in and around Building 937 to determine the location of the source of PCE (and TCE) in the Building 937 subslab vapor samples. The grab groundwater sampling proposed in this field sampling plan addendum will supplement existing groundwater data. The presence of PCE and other chlorinated solvents in soil gas in the Building 937 Area has not been characterized. Proposed soil gas sampling will determine whether VOCs are present in soil gas and potentially identify the location of the source of PCE and other chlorinated solvents in the subsurface. In addition, the sources of PCE may be located south of Building 937 (e.g., near or under Building 933). Subslab vapor, soil gas, and groundwater sampling has not been performed below the northern end of Building 933.	1. Are PCE or other volatile organic compounds (“VOCs”) detected in sub-slab vapor samples present in soil gas below Building 937? 2. Are PCE or other VOCs detected in subslab vapor samples present in groundwater below or south of Building 937? 3. If PCE or other VOCs are found in groundwater at a higher concentration than previously detected in historic groundwater samples or on-going groundwater monitoring, can the source of the contamination be identified? 4. If PCE or other VOCs are found in soil gas, can the source of the contamination be identified? 5. If PCE or other VOCs are present in groundwater, is groundwater remediation necessary? 6. If PCE or other VOCs are present in soil gas, is vadose zone remediation necessary? 7. If PCE or other VOCs are present in the soil, is vadose zone remediation necessary? 8. Are VOCs present above the risk-based action levels or Crissy Field cleanup levels in subslab vapor, soil, or groundwater below Building 933?	1. Results of previous chemical analysis of soil and groundwater samples from near and within Building 937. 2. Results of chemical analysis from subslab vapor sampling at Building 937. 3. Results of chemical analysis of groundwater, soil gas, and soil samples to be collected in the Building 937 Area. Soil gas samples are proposed to be analyzed in a mobile lab to allow for field decisions to be made regarding soil gas and soil sampling locations. 4. Results of Building 937 indoor air samples. 5. Physical properties from vadose zone sampling that will be used to develop site-specific soil, soil gas, and groundwater screening levels based on the vapor intrusion pathway. 6. Results of chemical analysis from sampling at Building 933.	The study boundary for the characterization investigation is the Building 937 Area, including the area south of Building 937 (an area in and around the northern portion of Building 933) to Building 945, an area north of Building 937.	During the soil gas investigation, as a conservative measure, if detected VOC concentrations in soil gas exceed residential California Human Health Screening Levels (“CHHSLs”), then a soil sample will be collected from that particular boring location. If detected VOC concentrations in soil gas exceed commercial/ industrial CHHSLs, then up to 3 soil samples may be collected from adjacent boring locations. If three or more soil gas samples trigger this clause, the appropriateness of the adjacent soil sampling will be discussed with the Trust, NPS, and DTSC. If concentrations of PCE or other VOCs in groundwater exceed applicable Crissy Field RAP groundwater cleanup levels, further characterization and potential remedial actions will be evaluated. If concentrations of PCE or other VOCs in groundwater exceed site-specific screening levels that could result in unacceptable concentrations of VOCs in indoor air through vapor intrusion, potential remedial actions will be evaluated. If concentrations of PCE or other VOCs in groundwater samples are below applicable Crissy Field groundwater cleanup levels and site-specific groundwater screening levels based on the vapor intrusion pathway, no further evaluation or action relative to groundwater is necessary. If concentrations of PCE or other VOCs are detected in soil or soil gas above site-specific screening levels based on the vapor intrusion pathway, then potential remedial actions will be evaluated. If concentrations of PCE or other VOCs are detected in soil and soil gas at less than site-specific screening levels based on the vapor intrusion pathway, then no further action relative to soil and soil gas is necessary. If the detected chemical concentrations in subslab vapor samples from Building 933 result in a calculated cumulative risk associated with vapor intrusion above 10⁻⁶ or a HI= 1, the Trust will collect indoor air samples in accordance with the Building 937 Field Sampling Plan dated 13 October 2005. Otherwise, indoor air samples will not be collected from Building 933. If concentrations of VOCs in soil or groundwater from samples from Building 933 exceed risk-based action levels or applicable Crissy Field cleanup levels, further characterization and potential remedial actions will be evaluated.	1. Field, analytical, and data validation procedures will follow the QAPP (Tetra Tech, 2001) to the extent possible. Duplicate samples (soil vapor and grab groundwater) will also be collected per the QAPP. 2. The mobile lab will not be able to meet the QAPP requirements for Level III and Level IV data packages. The Trust will collect duplicates for 10% of the soil gas samples in SUMMA canisters and send them to a fixed laboratory for analysis and data validation. 3. A potential error in evaluation of groundwater, soil, and soil gas samples would be to incorrectly quantify the chemicals present in groundwater, soil, or soil gas. The acceptable range of decision error would be a consequence of field and/or analytical errors and will be evaluated during the data validation procedures.	1. Up to fifteen new soil borings (937SB110 through 937SB121; and 933SB101 through 933SB103) will be installed, as shown on Figure 2: - At 10 of these boring locations both soil gas and grab groundwater samples will be collected. - At 3 boring locations inside Building 937 along the southern wall only soil gas samples will be collected (937SB115, 937SB116, and 937SB121). - At the 2 borings south of Building 937, to the east and west of Building 933, only grab groundwater samples will be collected (933SB101 and 933SB102). - Borings 937SB119, 937SB120, and 937SB121 may be moved or deleted based on soil gas results from other borings. 2. Grab groundwater samples will be collected at the two existing well points inside Building 937 (937WP01 and 937WP04). 3. Soil borings will be installed to collect grab groundwater samples at first encountered groundwater. Grab groundwater samples will be analyzed for VOCs using US EPA Method 8260. 4. Probes will be advanced to collect soil gas samples at approximately five feet below ground surface. Soil gas samples will be collected in a gas-tight syringe and analyzed by a mobile laboratory for VOCs using US EPA Method 8260. Duplicates of 10% of the soil gas samples will be collected in SUMMA canisters and analyzed at a fixed laboratory by US EPA Method TO-15. 5. Soil samples, if collected based on results of soil gas data, will be collected from approximately 2 feet below ground surface and analyzed for VOCs by EPA Method 8260B. 6. Two subslab vapor samples (933VS101 and 933VS102) will be collected from locations below the northern end of Building 933, as shown on Figure 2. Subslab vapor samples will be collected in SUMMA canisters and analyzed for the full scan of volatile organics with tentatively identified compounds (“TICs”) by US EPA Method TO-15 for quantitative results. Samples will be collected over approximately 20 minutes or as reasonable to fill the SUMMA canister. 7. At the request of a potential future Trust tenant, a soil sample and a groundwater sample will be collected from 933SB103 from approximately 8 feet below ground surface and analyzed for VOCs by EPA Method 8260B, Title 22 metals, and total petroleum hydrocarbons.

Abbreviations:	
CHHSLs	California Human Health Screening Levels
MCLs	maximum contaminant levels
QAPP	<i>Presidio-Wide Quality Assurance Project Plan, Sampling and Analysis Plan</i> , Tetra Tech EM Inc., dated April 2001.
PCE	Tetrachloroethene
TCE	Trichloroethene
VOCs	volatile organic compounds

TABLE 4
SAMPLE LABORATORY ANALYSIS MATRIX
BUILDING 937 VAPOR INTRUSION STUDY ADDENDUM

Presidio of San Francisco, California

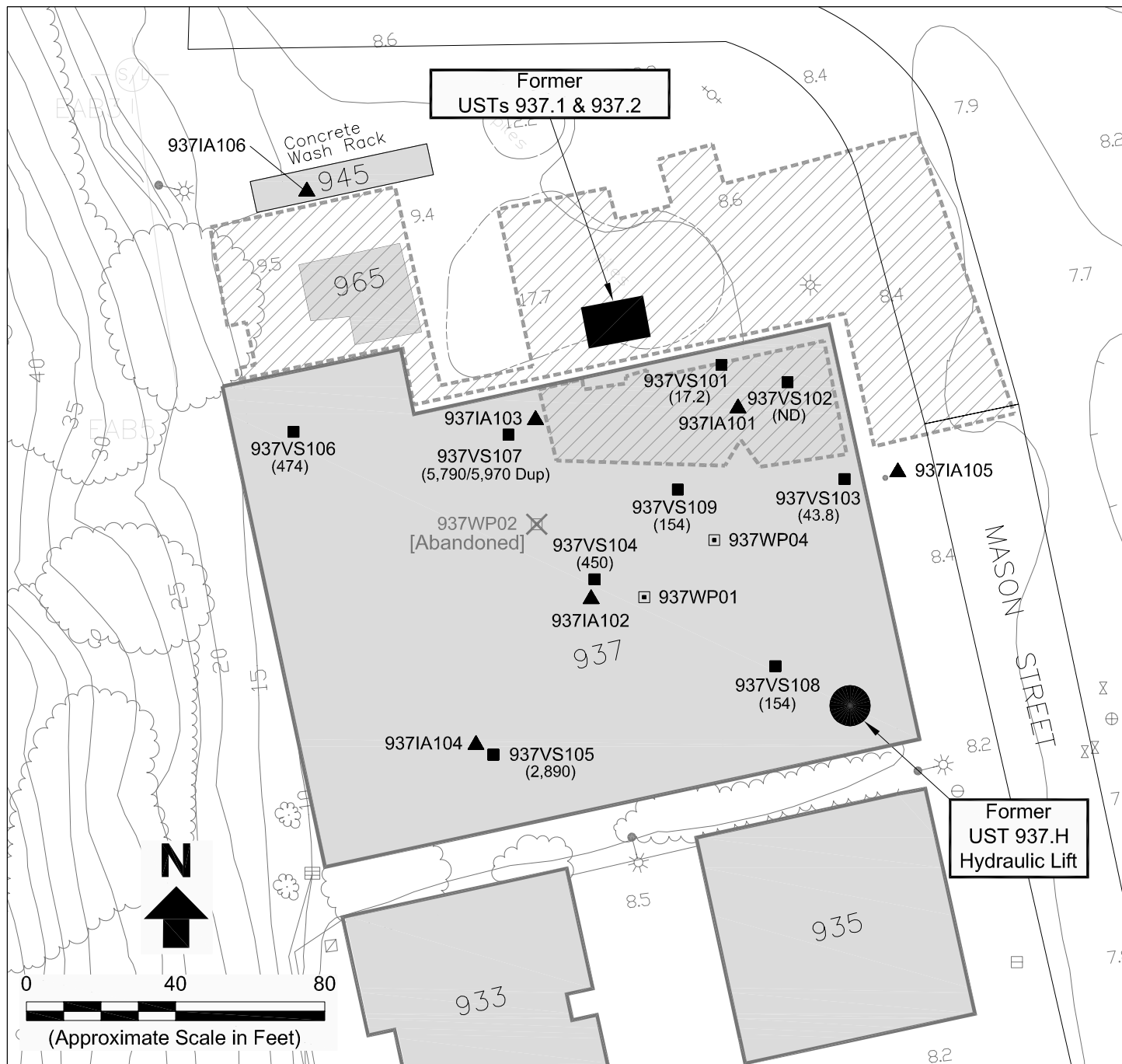
Sample ID (a) (b)	Laboratory Analyses				
	VOCs in Soil Gas by EPA Method 8260	VOCs in Groundwater by EPA Method 8260	VOCs in Soil by EPA Method 8260	VOCs in Subslab Vapor by EPA Method T0-15	Physical Parameters
937SB110	●	●	(d)		
937SB111	●	●	(d)		● (f)
937SB112	●	●	(d)		
937SB113	●	●	(d)		● (f)
937SB114	●	●	(d)		
937SB115	●		(d)		
937SB116	●		(d)		
937SB117	●	●	(d)		
937SB118	●	●	(d)		
937SB119 (c)	●	●	(d)		
937SB120 (c)	●	●	(d)		
937SB121 (c)	●		(d)		
937WP01		●			
937WP04		●			
933SB101		●			
933SB102		●			
933SB103	●	●	(d, e)		● (f)
933VS101				●	
933VS102				●	

Notes:

- (a) Sample identification follows the Presidio Trust Quality Assurance Project Plan ("QAPP") coding procedure with Trust wells and borings starting at 100. Soil gas samples will be collected at approximately five feet below ground surface.
- (b) Per QAPP guidance, one duplicate will be collected for every ten samples on each day of the field investigation. Duplicate samples will be noted with "DUP" in the Sample ID. Soil gas duplicates will be analyzed by EPA Method TO-15 in a fixed lab.
- (c) Borings 937SB119, 937SB120, and 937SB121 are contingent borings and may be moved or eliminated based on sample results of other borings.
- (d) Soil samples will be collected and analyzed only if soil gas concentrations exceed the trigger levels stated in Table 3, Data Quality Objectives.
- (e) A soil sample collected from 8 feet below ground surface will be analyzed for VOCs by EPA Method 8260, Title 22 metals by EPA Method 6020, and total petroleum hydrocarbons as gas and diesel by EPA Method 8015.
- (f) Up to 3 soil samples will be collected and analyzed for physical parameters to be used for vapor intrusion modeling (i.e., soil bulk density, soil grain density, total porosity, moisture content, total organic carbon content, and grain size distribution). Samples are planned to be analyzed by PTS Laboratories in their Cal-EPA Vapor Intrusion Package. Actual borings from which samples are collected may vary with field conditions and sample availability.

Abbreviation:

VOC = volatile organic compounds
April 2006

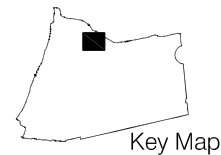


LEGEND

- Former UST Location
- ▨ Former Army Excavation Areas
- 937 Existing Building
- Well Point
- Subslab Vapor Sample Location
- ▲ Air Sample Location
- (450) PCE Concentration in $\mu\text{g}/\text{m}^3$

Abbreviations:

- UST = underground storage tank
- PCE = tetrachloroethene
- ND = not detected



Erler & Kalinowski, Inc.

Building 937 – PCE Concentrations in Subslab Vapor and Air Sampling Locations



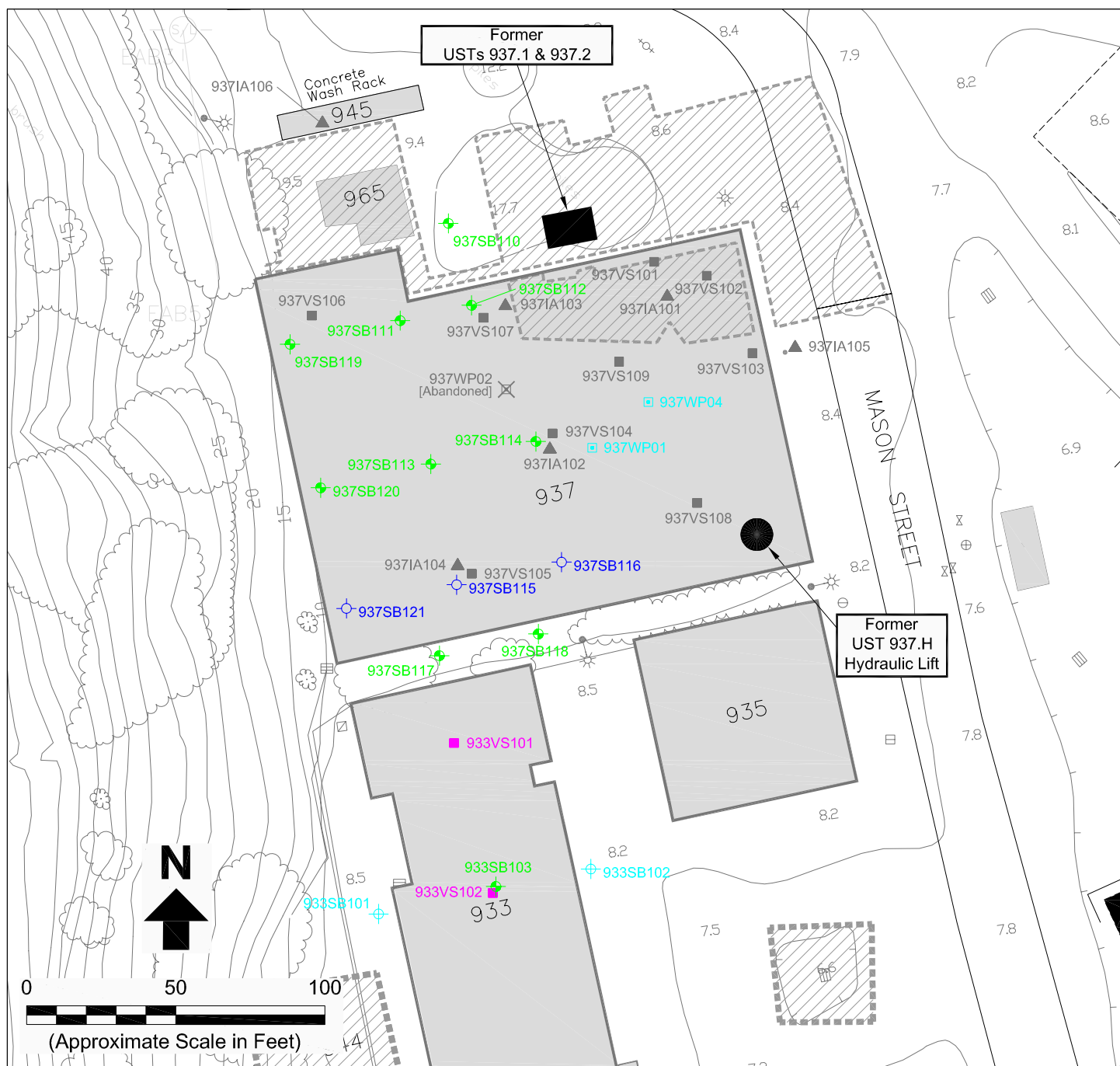
Presidio Trust
San Francisco, CA

April 2006
EKI A000003.08

Figure 1

Notes:

1. All locations are approximate.
2. Basemap provided by the Presidio Trust.
3. All subslab vapor samples collected on 1 December 2005.
4. Posted PCE concentrations have not been validated and are considered draft. The validated data will be presented in an upcoming report.



LEGEND

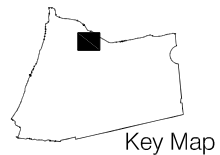
- Former UST Location
- ▨ Former Army Excavation Areas
- 937 Existing Building
- Existing Subslab Vapor Sample Location
- ▲ Existing Air Sample Location
- Existing Well Point to be Sampled
- ⊕ Proposed Grab Groundwater Sample Location
- Proposed Subslab Vapor Sample Location
- ⊕ Proposed Soil Gas Sample Location
- ⊕ Proposed Soil Gas and Grab Groundwater Sample Location

Abbreviations:

UST = underground storage tank

Notes:

1. All locations are approximate.
2. Basemap provided by the Presidio Trust.
3. Borings 937SB119, 120, and 121 may be moved or deleted based on soil gas results of other borings.



Erler & Kalinowski, Inc.



**Building 937
Existing and Proposed
Sampling Locations**

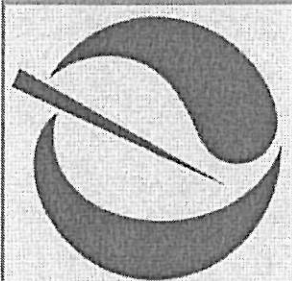
Presidio Trust
San Francisco, CA

April 2006
EKI A000003.08

Figure 2

Use of California Human Health Screening Levels (CHHSLs) in Evaluation of Contaminated Properties

January 2005



California Environmental Protection Agency

Table 2. California Human Health Screening Levels for Indoor Air and Soil Gas

Chemical	¹ Indoor Air Human Health Screening Levels ($\mu\text{g}/\text{m}^3$)		² Shallow Soil Gas Human Health Screening Levels (Vapor Intrusion) ($\mu\text{g}/\text{m}^3$)	
	Residential Land Use	Commercial/Industrial Land Use Only	Residential Land Use	Commercial/Industrial Land Use Only
Benzene	8.40 E-02	1.41 E-01	3.62 E+01	1.22 E+02
Carbon Tetrachloride	5.79 E-02	9.73 E-02	2.51 E+01	8.46 E+01
1,2-Dichloroethane	1.16 E-01	1.95 E-01	4.96 E+01	1.67 E+02
<i>cis</i> -1,2-Dichloroethylene	3.65 E+01	5.11 E+01	1.59 E+04	4.44 E+04
<i>trans</i> -1,2-Dichloroethylene	7.30 E+01	1.02 E+02	3.19 E+04	8.87 E+04
Ethylbenzene	Postponed ³	Postponed ³	Postponed ³	Postponed ³
Mercury, elemental	9.40 E-02	1.31 E-01	4.45 E+01	1.25 E+02
Methyl tert-Butyl Ether	9.35 E+00	1.57 E+01	4.00 E+03	1.34 E+04
Naphthalene	7.20 E-02	1.20 E-01	3.19 E+01	1.06 E+02
Tetrachloroethylene	4.12 E-01	6.93 E-01	1.80 E+02	6.03 E+02
Tetraethyl Lead	3.65 E-04	5.11 E-04	2.06 E-01	5.78 E-01
Toluene	3.13 E+02	4.38 E+02	1.35 E+05	3.78 E+05
1,1,1-Trichloroethane	2.29 E+03	3.21 E+03	9.91 E+05	2.79 E+06
Trichloroethylene	1.22 E+00	2.04 E+00	5.28 E+02	1.77 E+03
Vinyl Chloride	3.11 E-02	5.24 E-02	1.33 E+01	4.48 E+01
<i>m</i> -Xylene	7.30 E+02	1.02 E+03	3.19 E+05	8.87 E+05
<i>o</i> -Xylene	7.30 E+02	1.02 E+03	3.15 E+05 ⁴	8.79 E+05 ⁴
<i>p</i> -Xylene	7.30 E+02	1.02 E+03	3.17 E+05	8.87 E+05

Reference: Appendix 1, OEHHA Target Indoor Air Concentrations and Soil-Gas Screening Numbers for Existing Buildings under Residential and Industrial/Commercial land uses.

Notes:

- "Residential Land Use" screening levels generally considered adequate for other sensitive uses (e.g., day-care centers, hospitals, etc.). Commercial/industrial properties should be evaluated using both residential and commercial/industrial CHHSLs. A deed restriction that prohibits use of the property for sensitive purposes may be required at sites that are evaluated and/or remediated under a commercial/industrial land use scenario only. Calculation of cumulative risk may be required at sites where multiple contaminants with similar health effects are present. Carcinogens: CHHSLs based on target cancer risk of 10⁻⁶. Cal/EPA cancer slope factors used when available. Noncarcinogens: CHHSLs based on target hazard quotient of 1.0.
- Soil Gas: Screening levels based on soil gas data collected <1.5 meters (five feet) below a building foundation or the ground surface. Intended for evaluation of potential vapor intrusion into buildings and subsequent impacts to indoor-air. Soil gas data should be collected and evaluated at all sites with significant areas of VOC-impacted soil. Screening levels also apply to sites that overlie plumes of VOC-impacted groundwater.
- Calculation of a screening number for the chemical has been postponed (pp) until the toxicity criterion currently being developed by OEHHA is published as a final document.
- Representative Screening Numbers for mixed xylenes. The representative value for mixed xylenes is based on the calculated lowest one amongst the three isomers.

APPENDIX B

FIELD METHODS AND PROCEDURES FOR SUBSLAB SOIL VAPOR SAMPLING AND SOIL GAS SAMPLING

Buildings 933 and 937, Presidio of San Francisco, California

B-1.0 Subslab Soil Vapor Sampling

Two subslab soil vapor samples will be collected inside Building 933. To collect subslab soil vapor samples from beneath the interior slab, a small diameter hole (approximately 1-inch in diameter) will be drilled through the concrete in two stages. The first stage involves drilling a 1-inch diameter core hole 4 to 5-inches deep. The depth of the initial hole is intentionally selected to be slightly less than the full thickness of the slab. After the core is removed, cooling water that will have been introduced during coring will be removed using paper towels and a shop vacuum. Once the hole is dry, a Roto-hammer with a 3/4-inch bit will be used to penetrate the remaining concrete (usually 1 to 2-inches). As soon as the slab is breached, the Roto-hammer bit will be removed and dust vacuumed out of the hole for 3 to 5 seconds. A rubber stopper with tubing connected to the SUMMA canister purging/sampling train will be quickly inserted as shown on Figure A-1 copied from the October 2005 Field Sampling Plan. Subsurface conditions will be allowed to equilibrate for approximately 30 minutes before sampling.

Sampling will be accomplished using a sampling train that incorporates a laboratory-supplied 6-liter SUMMA canister, a vacuum tight valve, vacuum gauges, a 200 milliliter per minute flow controller, and an in-line particle filter connected with disposable Teflon tubing (Figure A-1). The soil vapor sample for volatile organic compounds ("VOCs") will be collected in the sample SUMMA canister. During sampling leak detection compounds, such as 1,1-difluoroethane or tetrafluoroethane, which are found in "dust-off" sprays, will be regularly discharged around all tubing joints where leakage of ambient air into the system could potentially occur. These compounds were selected as the leak detection compounds because they are non-toxic gases that are easily identifiable during analysis and do not occur at contaminated sites. Therefore, it does not interfere with the quantitative analysis of VOCs.

Each SUMMA canister will be individually certified as clean by the laboratory prior to use in the field. Once collected, each subslab soil vapor canister will be labeled and transported to the laboratory in accordance with the Quality Assurance Project Plan ("QAPP").

The slab penetration will be filled with grout and a concrete patch at the conclusion of sampling.

A field duplicate for quality assurance/quality control (“QA/QC”) analysis will be taken at 933VS101.

B-2.0 Soil Gas Sampling

Soil gas sampling will be conducted generally in accordance with Trust Standard Operating Procedure No. 011, Soil Gas Sampling Methods, found in the Trust QAPP, and the joint Department of Toxic Substances Control (“DTSC”) and Regional Water Quality Control Board, Los Angeles Region (“LARWQCB”) guidance, entitled *Advisory—Active Soil Gas Investigations* and dated 28 January 2003. Since an onsite mobile lab is planned for this field investigation, samples will be collected in a gas-tight syringe for injection within 30 minutes in the onsite lab gas chromatograph.

To collect soil gas samples, a boring will be advanced by direct push technology to the desired sampling depth, 5 feet below ground surface (“bgs”). Once the desired depth is achieved, a stainless steel implant connected to polyethylene tubing (1/4 or 1/8 inch diameter) will be placed in the bottom of the hole and covered with 6-12 inches of sand. Above the sand, the hole will be filled with hydrated bentonite to create a seal. The sample tubing will protrude through the bentonite to allow collection of the soil gas sample from the implant. Subsurface conditions will be allowed to equilibrate for 30 minutes before purging and sampling in accordance with current state guidelines. A purge volume step test will be conducted for the first soil gas sample in accordance with the state Advisory.

During sampling leak detection compounds, such as 1,1-difluoroethane or tetrafluoroethane, which are found in “dust-off” sprays, will be regularly discharged around all tubing joints where leakage of ambient air into the system could potentially occur. These compounds were selected as the leak detection compounds because they are non-toxic gases that are easily identifiable during analysis and do not occur at contaminated sites. Therefore, it does not interfere with the quantitative analysis of VOCs.

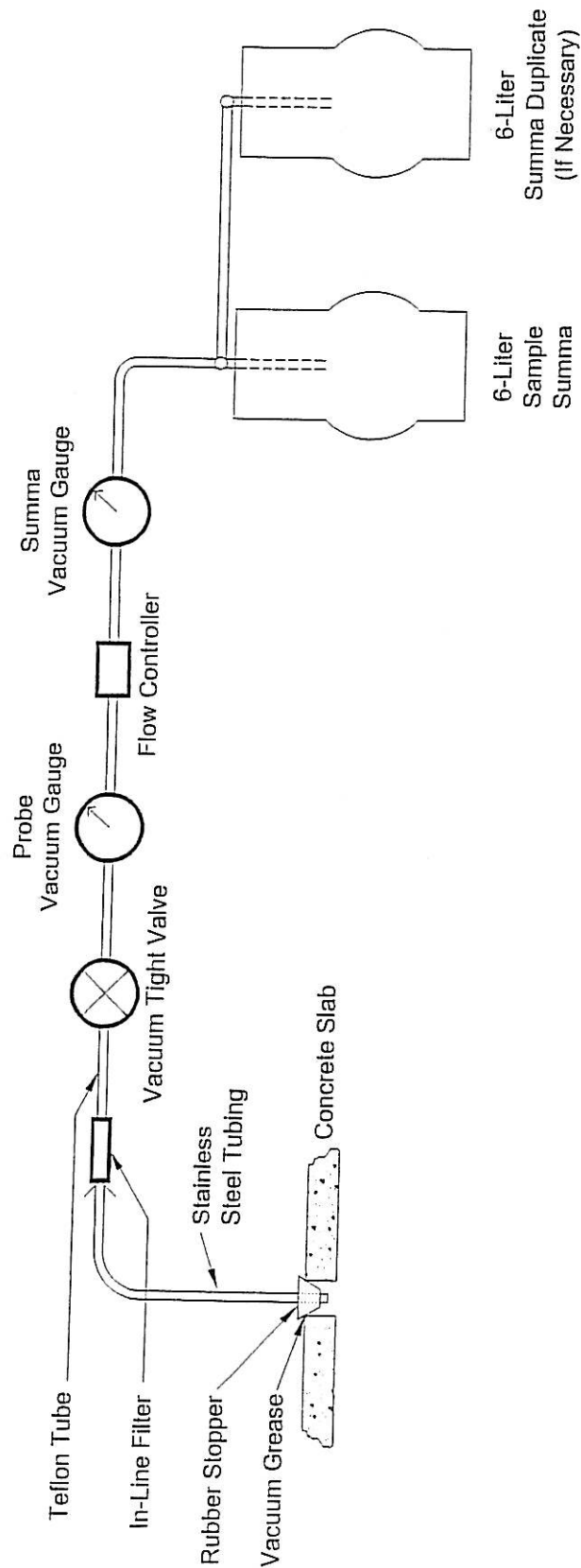
Field duplicate soil gas samples for analysis at a fixed laboratory will be collected in six-liter SUMMA canisters.

When sampling has been completed, the tubing will be removed and the bentonite will seal the boring. Borings within concrete or asphalt will be repaved upon completion of the work.

B-3.0 Disposal of Investigation-Derived Wastes

Wastes generated during the investigations at Buildings 933 and 937 will include concrete cuttings and cooling water used during concrete boring, pails of soil cores, decontamination water, groundwater purge water, as well as gloves and other personal protective equipment. Since neither cooling water nor concrete will have been in contact

with contaminated soil, these wastes may be disposed as non-hazardous debris in regular trash. The soil cores, decontamination water, and groundwater purge water will require characterization before disposal. Disposal of all wastes will be the responsibility of the Trust.



Erlar & Kalinowski, Inc.

Sub-Slab Soil Vapor Sampling Configuration



Presidio Trust
San Francisco, CA
October 2005
EKI A000003.08
Figure A-1

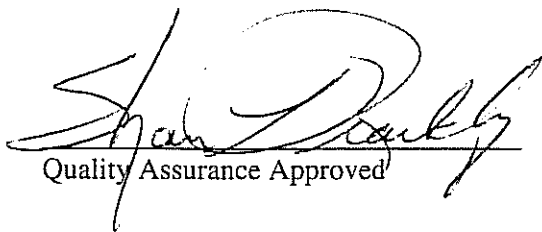
SOP APPROVAL FORM

**THE PRESIDIO TRUST
ENVIRONMENTAL STANDARD OPERATING PROCEDURE**

SOIL SAMPLING

**SOP NO. 001
REVISION NO. 00**

Last Reviewed: December 2000


Quality Assurance Approved

12 JAN 01
Date

1.0 BACKGROUND

Soil sampling is conducted for three main reasons. First, samples can be obtained for laboratory chemical analysis. Second, samples can be obtained for laboratory physical analysis. Third, samples can be obtained for visual classification and field screening. These three sampling objectives can be achieved separately or in combination with each other. Sampling locations are typically chosen to provide chemical, physical, or visual information in both the horizontal and vertical directions. A sampling and analysis plan is used to outline sampling methods and provide preliminary rationale for sampling locations. Sampling locations may be adjusted in the field based on the screening methods being used and the physical features of the area.

1.1 PURPOSE

Soil sampling is conducted to determine the chemical, physical, and visual characteristics of surface and subsurface soils.

1.2 SCOPE

This standard operating procedure (SOP) describes procedures for soil sampling in different areas using various implements. It includes procedures for test pit, surface soil, and subsurface soil sampling, and describes eight devices. It also discusses procedures for collecting soil samples for volatile organic compound (VOC) analysis using the EnCore™ soil sampler system.

1.3 DEFINITIONS

Hand Auger: Instrument attached to the bottom of a length of pipe that has a crossarm or “T”-handle at the top. The auger can be closed-spiral or open-spiral.

Bucket Auger: A type of auger that consists of a cylindrical bucket 10 to 72 inches in diameter with teeth arranged at the bottom.

Core Sampler: Thin-wall cylindrical metal tube with diameter of 0.5 to 3 inches, a tapered nosepiece, a T-handle to facilitate sampler deployment and retrieval, and a check valve (flutter valve) in the headpiece.

Spatulas or Spoons: Stainless steel instruments for collecting loose unconsolidated material.

Trier: Tube cut in half lengthwise with a sharpened tip that allows for collection of sticky solids or loosening of cohesive soils.

Trowel: Tool with a scooped blade 4 to 8 inches long and 2 to 3 inches wide and has a handle.

Split-Spoon (or Split-Barrel) Sampler: Thick-walled steel tube that is split lengthwise. A cutting shoe is attached to the lower end; the upper end contains a check valve and is connected to drill rods.

Thin-Wall Tube Sampler: Steel tube (1 to 3 millimeters thick) with tapered bottom edge for cutting. The upper end is fastened to a check valve that is attached to drill rods.

1.4 REFERENCES

- Barth, D.S., and B.J. Mason. 1984. "Soil Sampling Quality Assurance Users Guide." EPA 600/4-84-043.
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- Mason, B.J. 1983. "Preparation of Soil Sampling Protocol: Techniques and Strategies." EPA 600/4-83-020.
- U.S. Environmental Protection Agency (EPA). 1987. "A Compendium of Superfund Field Operations Methods." Office of Solid Waste and Emergency Response Directive 9355.0-14 (EPA/540/P-87/001).
- EPA. 1991. "Handbook of Suggested Practices for the Design and Installation of Groundwater Monitoring Wells." EPA/600/4-89/034. March.
- EPA. 1994. "Soil Sampling." Environmental Response Team SOP No. 2012. Revision No. 0.0. November 16. (On-Line Address: http://www.ert.org/media_resrcs/media_resrcs.asp.)

1.5 REQUIREMENTS AND RESOURCES

Soil sampling requires that one or more of the following types of equipment be used:

Sampling Equipment

Spoons and spatulas
Trowel
Shovel or spade
Trier
Core sampler

Other Required Equipment

Sample containers, labels, and chain-of-custody forms
Logbook
Measuring tape
Soil classification guidelines
Wax for sealing ends of thin-wall tube

Hand auger	Plastic sheeting
Bucket auger	Decontamination equipment
Split-spoon	Drilling equipment
Thin-wall tube	Backhoe
	Health and safety equipment

2.0 PROCEDURES

This SOP presents procedures for conducting test pit, surface soil, and subsurface soil sampling. The project-specific field sampling plan will specify which of the following procedures will be used.

Soil samples for chemical analysis should be collected in the following order: (1) VOCs, (2) semivolatile organic compounds, and (3) metals. Once the chemical samples have been containerized, samples for physical analyses can be containerized. Typical physical analyses conducted include (1) grain size distribution, (2) moisture content, (3) saturated permeability, (4) unsaturated permeability, and (5) Atterberg limits. Additionally, visual descriptions of samples, using the Unified Soil Classification System (USCS), should be recorded. Soil samples for chemical analyses can be collected either as grab samples or composite samples. A grab sample is collected from a discrete location or depth. A composite sample consists of soil combined from more than one discrete location. Typically, composite samples consist of soil obtained from several locations and homogenized in a stainless steel or Teflon[®] pan or tray. Samples for VOC analysis should not be composited.

2.1 TEST PIT SOIL SAMPLING

Test pit soil sampling is conducted when a complete soil profile is required or as a means of locating visually detectable contamination or sources, such as debris and underground storage tanks. This type of sampling provides a detailed description of the soil profile and allows for multiple samples to be collected from specific soil horizons. Before conducting any test pit or trench excavation with a backhoe, the sampling team should ensure that the sampling area is clear of utility lines, subsurface pipes, and poles. Any intrusive activities require Trust project review and permit issuance.

A test pit or trench is excavated by incrementally removing soil material with a backhoe bucket. The excavated soil may be placed on plastic sheeting (or other means of segregation), well away from the edge of the test pit. A test pit with depths greater than 4 feet must have its walls properly stabilized

according to Occupational Safety and Health Administration standards if personnel access to the pit is required. In many applications, sampling from the backhoe bucket will be preferred.

Personnel entering the test pit may be exposed to toxic or explosive gases and oxygen deficient environments. Air monitoring is required before entering the test pit and the use of appropriate respiratory gear and protective clothing is mandatory. At least two persons must be present at the test pit before sampling personnel enter the excavation and begin soil sampling.

Test pits are not practical for depths greater than 15 feet. If soil samples are required from depths greater than 15 feet, samples should be obtained using test borings instead of test pits. Test pits are also usually limited to a few feet below the water table. In some cases, a pumping system may be required to control the water level within the pits.

Access to open test pits should be restricted by use of flagging, tape, or fencing. If a fence is used, it should be erected at least 6 feet from the perimeter of the test pit. The test pit should be backfilled as soon as possible after sampling is completed.

Soil samples can be collected from the walls or bottom of a test pit using various equipment. A hand auger, bucket auger, or core sampler can be used to obtain samples from various depths. A trier, trowel, or spoons can be used to obtain samples from the walls or pit bottom surface.

2.2 SURFACE SOIL SAMPLING

The surface (and near surface) soil sampling equipment presented in this SOP is best suited for sampling to depths of 0 to 6 feet below ground surface (bgs). The sample depth, sample analyses, soil type, and soil moisture will also dictate the best-suited sampling equipment. Before sample collection, the sampling locations should be cleared of any surface debris such as twigs, rocks, and litter. The following table presents various surface soil sampling equipment and their effective depth ranges, operating means (manual or power), and sample types collected (disturbed or undisturbed).

Sampling Equipment	Effective Depth Range (feet bgs)	Operating Means	Sample Type
Hand Auger	0 to 6	Manual	Disturbed
Bucket Auger	0 to 4	Power	Disturbed
Core Sampler	0 to 4	Manual or Power	Undisturbed

Shovel	0 to 6	Manual	Disturbed
Trier	0 to 1	Manual	Disturbed
Trowel	0 to 1	Manual	Disturbed
Spoon/Spatula	0 to 0.5	Manual	Disturbed

The procedures for using these various types of sampling equipment are discussed below.

2.2.1 Hand Auger

A hand auger equipped with extensions and a T-handle is used to obtain samples from a depth of up to 6 feet below ground surface. If necessary, a shovel may be used to excavate the topsoil to reach the desired subsoil level. If topsoil is removed, its thickness should be recorded. Samples obtained using a hand auger are disturbed in their collection; determining the exact depth at which samples are obtained is difficult.

The hand auger is screwed into the soil at an angle of 45 to 90 degrees from horizontal. When the entire auger blade has penetrated soil, the auger is removed from the soil by lifting it straight up without turning it, if possible. If the desired sampling depth has not been reached, the soil is removed from the auger and deposited onto plastic sheeting. This procedure is repeated until the desired depth is reached and the soil sample is obtained. The auger is then removed from the boring and the soil sample is collected directly from the auger into an appropriate sample container.

2.2.2 Bucket Auger

A bucket auger, equipped similarly as the hand auger, is used to obtain disturbed samples from a depth of up to 4 feet. A bucket auger should be used when sampling stony or dense soil that prohibits the use of a hand-operated core or screw auger. A bucket auger with closed blades is used in soil that cannot generally be penetrated or retrieved by a core sampler.

The bucket auger is rotated while downward pressure is exerted until the bucket is full. The bucket is then removed from the boring, the collected soil is placed on plastic sheeting, and this procedure is repeated until the appropriate depth is reached and a sample is obtained. The bucket is then removed from the boring and the soil sample is transferred from the bucket to an appropriate sample container.

2.2.3 Core Sampler

A hand-operated core sampler (Figure 1), similarly equipped as the hand auger, is used to obtain samples from a depth of up to 4 feet in uncompacted soil. The core sampler is capable of retrieving undisturbed soil samples and is appropriate when low concentrations of metals or organics are of concern. The core sampler should be constructed of stainless steel. A polypropylene core sampler is generally not suitable for sampling dense soils or sampling at an appreciable depth.

The core sampler is pressed into the soil at an angle of 45 to 90 degrees from horizontal and is rotated when the desired depth is reached. The core is then removed, and the sample is placed into an appropriate sample container.

2.2.4 Shovel

A shovel may be used to obtain large quantities of soil that are not readily obtained with a trowel but is not recommended. A shovel is used when soil samples from a depth of up to 6 feet are to be collected by hand excavation; a tiling spade (sharpshooter) is recommended for excavation and sampling. A standard steel shovel may be used for excavation; either a stainless steel or polypropylene shovel may be used for sampling. Soil excavated from above the desired sampling depth should be stockpiled on plastic sheeting. Soil samples should be collected from the shovel and placed into the sample container using a stainless-steel scoop, plastic spoon, or other appropriate tool.

2.2.5 Trier

A trier (Figure 2) is used to sample soil from a depth of up to 1 foot. A trier should be made of stainless steel or polypropylene. A chrome-plated steel trier may be suitable when samples are to be analyzed for organics and heavy metal content is not a concern.

Samples are obtained by inserting the trier into soil at an angle of up to 45 degrees from horizontal. The trier is rotated to cut a core and is then pulled from the soil being sampled. The sample is then transferred to an appropriate sample container.

2.2.6 Trowel

A trowel is used to obtain surface soil samples that do not require excavation beyond a depth of 1 foot. A trowel may also be used to collect soil subsamples from profiles exposed in test pits. Use of a trowel is practical when sample volumes of approximately 1 pint (0.5 liter) or less are to be obtained. Excess soil should be placed on plastic sheeting until sampling is completed. A trowel should be made of stainless steel (or galvanized steel for samples that are analyzed for metals). It can be purchased from a hardware or garden store. Soil samples to be analyzed for organics should be collected using a stainless steel trowel. Samples may be placed directly from the trowel into sample containers.

2.3 SUBSURFACE SOIL SAMPLING

Subsurface soil sampling, in conjunction with borehole drilling, is required for soil sampling from depths greater than approximately 6 feet. Subsurface soil sampling is frequently coupled with exploratory boreholes or monitoring well installation. Refer to SOP No. 004 for monitoring well installation and borehole drilling procedures. Prior to intrusive soil sampling activities, site utilities may be required to be cleared by a qualified utility locator. As noted previously, intrusive soil activities also require Trust project review and permit issuance.

Subsurface soil sampling may be conducted using a drilling rig or power auger. Selection of sampling equipment depends upon geologic conditions and the scope of the sampling program. Two types of samplers used with machine-driven augers—the split-spoon sampler and the thin-wall tube sampler—are discussed below. All sampling tools should be cleaned before and after each use in accordance with SOP No. 014 (General Equipment Decontamination). Both the split-spoon sampler and the thin-wall tube sampler can be used to collect undisturbed samples from unconsolidated soils. Direct-push methods are commonly used to drive tube samplers equipped with acetate or brass sleeves. Acetate sleeves permit the recovery of a continuous core (typically 4-foot lengths) that can be divided for chemical or other analyses. The procedures for using the split-spoon and thin-wall tube samplers are presented below.

2.3.1 Split-Spoon Sampler

Split-spoon samplers are available in a variety of types and sizes. Site conditions and project needs (such as large sample volume for multiple analyses) determine the specific type of split-spoon sampler to be used. Figure 3 shows a generic split-spoon sampler.

The split-spoon sampler is advanced into the undisturbed soil beneath the bottom of the casing or borehole using a weighted hammer and a drill rod. The relationship between hammer weight, hammer drop, and number of blows required to advance the split-spoon sampler in 6-inch increments indicates the density or consistency of the subsurface soil. After the split-spoon sampler has been driven to its intended depth, it should be removed carefully to avoid loss of sample material. In noncohesive or saturated soil, a catcher or basket should be used to help retain the sample.

After the split-spoon sampler is removed from the casing, it is detached from the drill rod and opened. If VOC samples are to be collected, EnCore™ samplers should be filled with soil taken directly from the split-spoon sampler (see Section 2.4). Samples for other specific chemical analyses should be taken as soon as the VOC sample has been collected. The remainder of the recovered soil can then be used for visual classification of the sample and containerized for physical analysis. The entire sample (except for the top several inches of possibly disturbed material) is retained for analysis or disposal.

2.3.2 Thin-Wall Tube Sampler

A thin-wall tube sampler, sometimes called the Shelby tube (Figure 4), may be pressed or driven into soil inside a hollow-stem auger flight, wash bore casing, or uncased borehole. The tube sampler is pressed into the soil without rotation to the desired depth or until refusal. If the tube cannot be advanced by pushing, it may be necessary to drive it into the soil without rotation using a hammer and drill rod. The tube sampler is then rotated to collect the sample from the soil and removed from the borehole.

After removal of the tube sampler from the drilling equipment, the tube sampler should be inspected for adequate sample recovery. The sampling procedure should be repeated until an adequate soil core is obtained (if sample material can be retained by the tube sampler). The soil core obtained should be documented in the logbook. Any disturbed soil is removed from each end of the tube sampler. If chemical analysis is required, VOC samples must be collected immediately after the tube sampler is withdrawn (see Section 2.4). Before use, and during storage and transport, the tube sampler should be capped with a nonreactive material. For physical sampling parameters, the tube sampler should be sealed by pouring three 0.25-inch layers of sealing liquid (such as wax) in each end, allowing each layer to solidify before applying the next. The remaining space at each end of the tube is filled with Ottawa sand or other, similar sand, which is allowed to settle and compact. Plastic caps are then taped over the ends of the tube. The top and bottom of the tube sampler should be labeled and the tube sampler should be stored accordingly.

2.4 **ENCORE™ SOIL SAMPLER SYSTEM FOR VOC ANALYSES**

The EnCore™ soil sampler system is a dedicated system designed to collect, store, and deliver an approximately 5- or 25-gram soil sample in a zero-headspace container. The samplers are applicable to the collection of samples for VOC analyses (including chlorinated and aromatic VOCs and purgeable total petroleum hydrocarbons). No preservation chemicals are needed in the field. Extrusion and extraction of the whole sample in the sampler is done in the laboratory. No subsampling of the individual container is necessary. The EnCore™ sampler is a single use device and cannot be cleaned or reused. The EnCore™ system consists of the following four components:

- A cartridge with moveable plunger
- A cap with two locking arms
- A T-handle to aid in sampling
- An extrusion handle used in the laboratory

The soil collected in the EnCore™ sampler is stored in a sealed, headspace-free state. Three Viton “O”-rings achieve the seals (two located on the plunger and one on the cap of the sampler). For correct sealing, these O-rings must not be removed or disturbed.

The following procedures should be followed to collect a soil sample with the EnCore™ sampler:

- Before collecting the sample, hold the coring body and push the plunger rod down until small rod rests against the tabs (to ensure that the plunger moves freely). Then, depress locking lever on T-handle and place the coring body, plunger end first, into the open end of the T-handle, aligning the two slots on the coring body with the two locking pins in the T-handle. Twist the coring body clockwise to lock the pins in the slot. Check to ensure sampler is locked in place.
- Turn the T-handle such that the “T” is up and the coring body is down. This position leaves the plunger body flush with the bottom of the coring body. Holding the T-handle, push and twist the sampler into the soil until the coring body is completely full. When the sampler is full, the small O-ring on the plunger rod will be centered in the T-handle viewing hole (the upper hole for the 25-gram sampler and the lower hole for the 5-gram sampler). Remove the sampler from the soil.

- Before capping the sampler, wipe excess soil from the coring body exterior, ridge area, and any soil that may protrude beyond the opening end of the coring body to ensure proper sealing. Cap the coring body while it is still on the T-handle. Continue as above until three samples have been collected from the location. If only VOCs are to be analyzed for a given location, a small jar (minimum 2 ounce) of sample must be collected to allow for moisture content analysis.

When sampling surface soils, apply the EnCore™ sampler to a freshly exposed soil surface, following the procedures described above. When sampling subsurface soils, EnCore™ samples should be collected from one of the open ends of a sleeve core immediately upon retrieval.

The EnCore™ sampling system cannot be reliably used as stated above to sample sand, loose soil, or sediment since a cohesive plug will not be formed with these materials. When working with these soils, pull the plunger all the way back and lock it. Turn the sampler upside down and scoop the material into the coring body and cap it. Make a note of this method deviation in the field notebook.

Place the three collocated samples for each VOC analysis into one zipper bag. Seal the bag, place it into a prechilled cooler maintained at 4°C, and ship the samples to the laboratory for preservation and analysis. The recommended holding time between sampling and preservation by the laboratory is 48 hours. The recommended holding time between preservation and analysis is 14 days. The laboratory will preserve two EnCore™ containers using sodium bisulfate and one container using methanol. This allows for both low-level and high-level analysis of the sample.

FIGURE 1
HAND-OPERATED CORE SAMPLER

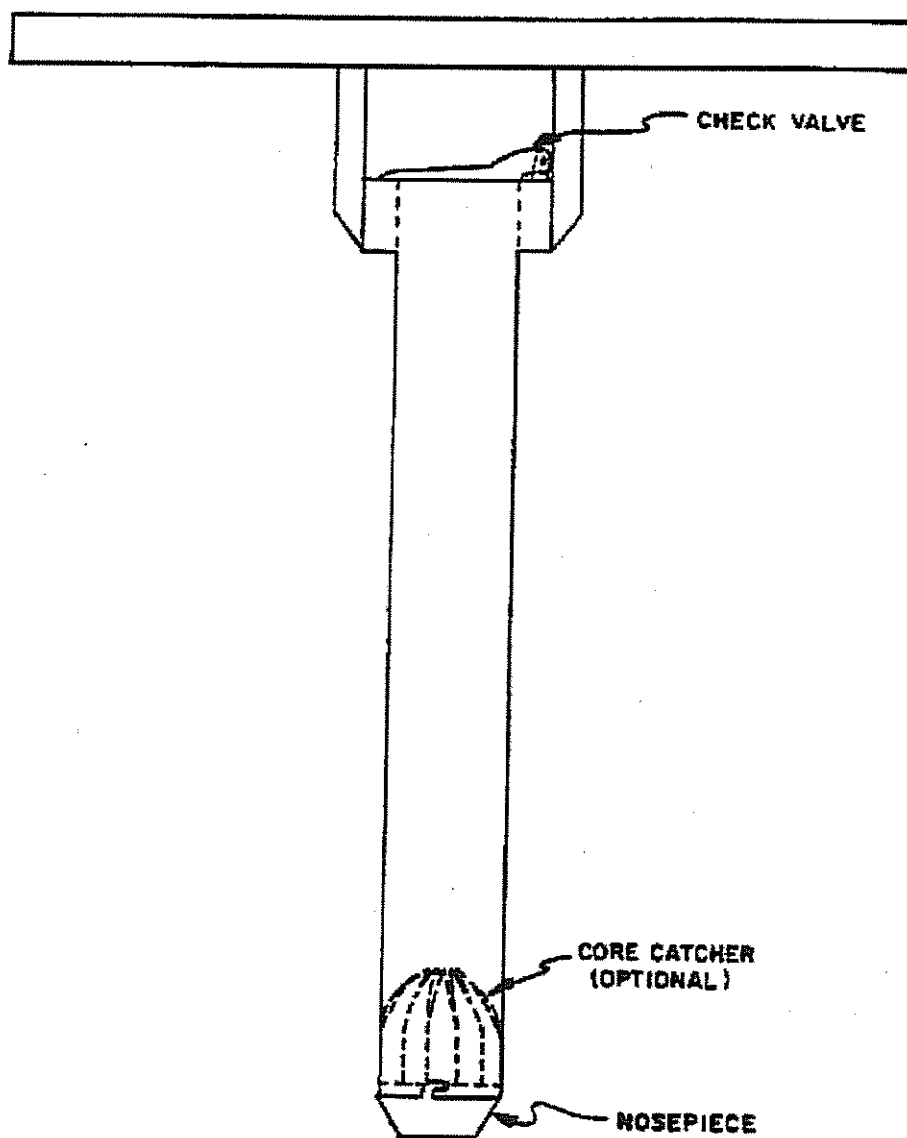


FIGURE 2
TRIER

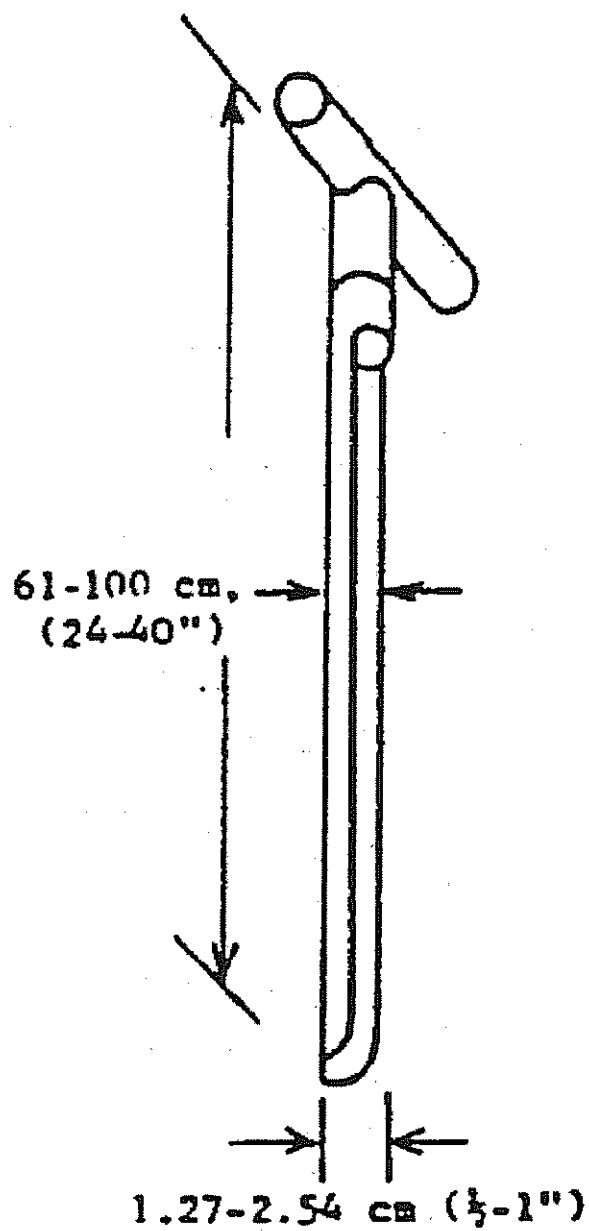


FIGURE 3
GENERIC SPLIT-SPOON SAMPLER

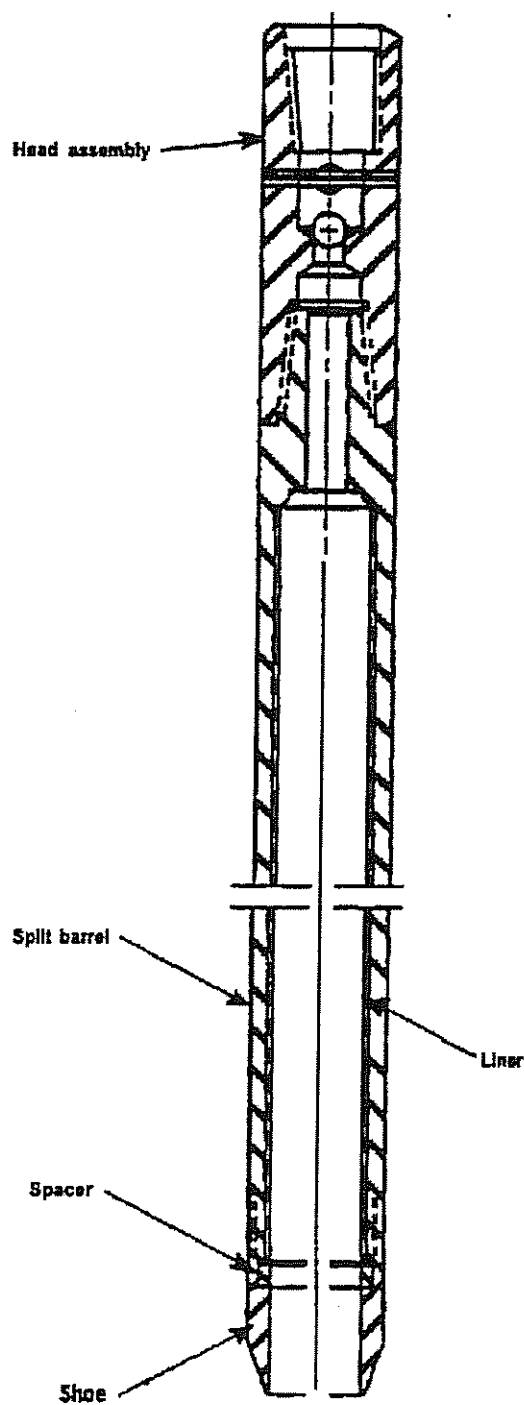
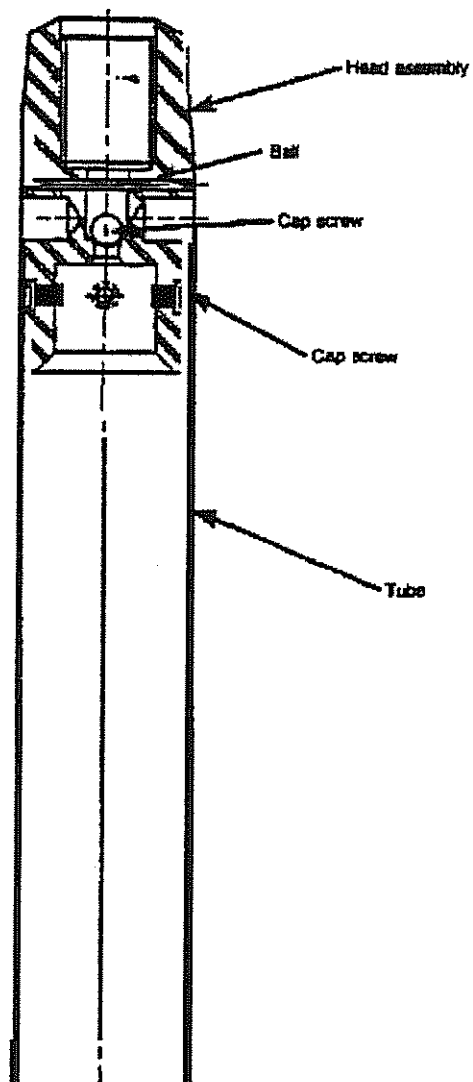


FIGURE 4
THIN-WALL TUBE SAMPLER



SOP APPROVAL FORM

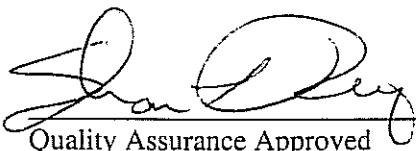
**THE PRESIDIO TRUST
ENVIRONMENTAL STANDARD OPERATING PROCEDURE**

**GROUNDWATER SAMPLE COLLECTION
USING LOW-FLOW TECHNOLOGY**

SOP NO. 003

REVISION NO. 00

Last Reviewed: December 2000


Quality Assurance Approved

12 JAN 01
Date

1.0 BACKGROUND

Groundwater sample collection is an integral part of site characterization at many contaminant release investigation sites. Often, a requirement of groundwater contaminant investigation is to evaluate contaminant concentrations in the aquifer. Since data quality objectives of most investigations require a laboratory setting for chemical analysis, samples must be collected from the aquifer and submitted to a laboratory for analysis. Therefore, sample collection and handling must be conducted in a manner that minimizes alteration of chemical characteristics of the groundwater.

In the past, most sample collection techniques followed federal and state guidance. Acceptable protocol included removal of water in the casing of a monitoring well (purging), followed by sample collection. The water in the casing was removed so groundwater from the formation could flow into the casing and be available for sample collection. Sample collection was commonly completed with a bailer, bladder pump, controlled flow impeller pump, or peristaltic pump. Samples were preserved during collection. Often, samples to be analyzed for metals contamination were filtered through a 0.45-micron filter prior to preservation and placement into the sample container.

Research conducted by several investigators has demonstrated that a significant component of contaminant transport occurs while the contaminant is sorbed onto colloid particles. Colloid mobility in an aquifer is a complex, aquifer-specific transport issue, and its description is beyond the scope of this standard operating procedure (SOP). However, concentrations of suspended colloids have been measured during steady-state conditions and during purging activities. Investigation results indicate standard purging procedures can cause a significant increase in colloid concentrations, which in turn may bias analytical results.

Low-flow sample collection provides a method of minimizing increased colloid mobilization by removing water from the well at the screened interval at a rate that preserves or minimally disrupts steady-state flow conditions in the aquifer. During low-flow sampling, groundwater is discharged from the aquifer at a rate that the aquifer will yield without creating a cone of depression around the sampled well. Research indicates that colloid mobilization will not increase above steady-state conditions during low-flow discharge. Therefore, the collected sample is more likely to represent steady-state groundwater chemistry.

1.1 PURPOSE

The purpose of this SOP is to describe the procedures to be used to collect a groundwater sample from a well using the low-flow technology. The following sections describe the equipment to be used and the methods to be followed to promote uniform sample collection techniques by field personnel that are experienced in sample collection and handling for environmental investigations.

1.2 SCOPE

This SOP applies to groundwater sampling using the low-flow technology. It is intended for use as an alternate SOP to the general “Groundwater Sampling” SOP (SOP No. 002), which provides guidance for the general aspects of groundwater sampling.

1.3 DEFINITIONS

Colloid: Suspended particles that range in diameter from 5 nanometers to 0.2 micrometer.

Dissolved Oxygen: The ratio of the concentration or mass of oxygen in water relative to the partial pressure of gaseous oxygen above the liquid which is a function of temperature, pressure, and concentration of other solutes.

Flow-through Cell: A device connected to the discharge line of a groundwater purge pump that allows regular or continuous measurement of selected parameters of the water and minimizes contact between the water and air.

pH: The negative base-10 logarithm of the hydrogen-ion activity in moles per liter.

Reduction and Oxidation Potential: A numerical index of the intensity of oxidizing or reducing conditions within a system, with the hydrogen-electrode potential serving as a reference point of zero volts.

Specific Conductance: The reciprocal of the resistance in ohms measured between opposite faces of a centimeter cube of aqueous solution at a specified temperature.

Turbidity: A measurement of the suspended particles in a liquid that have the ability to reflect or refract part of the visible portion of the light spectrum.

1.4 REFERENCES

Puls, R.W., and M.J. Barcelona. 1996. "Low-Flow (Minimal Drawdown) Groundwater Sampling Procedures." U.S. Environmental Protection Agency. Office of Research and Development. EPA/540/S-95/504. April.

1.5 REQUIREMENTS AND RESOURCES

The following equipment is required to complete low-flow sample collection:

- Water level indicator
- Adjustable flow rate pump (bladder, piston, peristaltic, or impeller)
- Discharge flow controller
- Flow-through cell
- pH probe
- Dissolved oxygen (DO) probe
- Turbidity meter
- Oxidation and reduction (Redox or Eh) probe
- Specific conductance (SC) or salinity probe (optional)
- Temperature probe (optional)
- Meter to display data for the probes
- Calibration solutions for pH, SC, turbidity, and DO probes, as necessary
- Container of known volume for flow measurement or calibrated flow meter
- Data recording and management system

2.0 PROCEDURES

The following procedures and criteria were modified from U.S. Environmental Protection Agency guidance titled "Low-Flow (Minimal Drawdown) Groundwater Sampling Procedures" (Puls and

Barcelona 1996). This reference may be consulted for a more detailed description of low-flow sampling theory.

Low-flow sampling is most commonly accomplished with low-discharge rate pumps, such as bladder, piston, controlled velocity impeller, or peristaltic pumps. Bailers and high capacity submersible pumps are not considered acceptable low-flow sample collection devices. The purged water is monitored (in a flow-through cell or other constituent monitoring device) for chemical and optical parameters that indicate steady-state flow conditions between the sample extraction point and the aquifer. Samples are collected when steady-state conditions are indicated.

Groundwater discharge equipment may be permanently installed in the monitoring well as a dedicated system, or it can be installed in each well as needed. Most investigators agree that dedicated systems will provide the best opportunity for collecting samples most representative of steady-state aquifer conditions, but the scope of a particular investigation and available investigation funds will dictate equipment selection.

2.1 EQUIPMENT CALIBRATION

Prior to sample collection, the monitoring equipment used to measure pH, Eh, DO, turbidity, and SC should be calibrated or checked according to manufacturer's directions. Typically, calibration activities are completed at the field office at the beginning of sampling activities each day. The pH meter calibration should bracket the pH range of the wells to be sampled (acidic to neutral pH range [4.00 to 7.00] or neutral to basic pH range [7.00 to 10.00]). The DO meter should be calibrated to one point (air-saturated water) or two points (air-saturated water and water devoid of all oxygen). The SC meter cannot be calibrated in the field. It is checked against a known standard (typical standards are 1, 10, and 50 millimhos per centimeter at 25 °C). The offset of the measured value of the calibration standard can be used as a correction value. Similarly, the Eh probe cannot be calibrated in the field, but is checked against a known standard, such as Zobell solution. The instrument should display a millivolt (mV) value that falls within the range set by the manufacturer. Because Eh is temperature dependent, the measured value should be corrected for site-specific variance from standard temperature (25 °C). The Eh probe should be replaced if the reading is not within the manufacturer's specified range. All calibration data should be recorded on the Low-flow Groundwater Sampling Data Sheet attached to this SOP (or equivalent).

2.2 WELL PURGING

The well to be sampled should be opened and groundwater in the well allowed to equilibrate to atmospheric pressure. Equilibration should be determined by measuring depth to water below the marked reference on the wellhead (typically the top of the well casing) over two or more 5-minute intervals. Equilibrium conditions exist when the measured depth to water varies by less than 0.01 foot over two consecutive readings. Total depth of well measurement should be made following sample collection, unless the datum is required to place nondedicated sample collection equipment. Depth to water and total well depth measurements should be made in accordance with procedures outlined in SOP No. 002 (Static Water Level, Total Well Depth, and Immiscible Layer Measurement).

If the well does not have a dedicated sample collection device, a new or previously decontaminated portable sample collection device should be placed within the well. The intake of the device should be positioned based on the fate and transport and lithological conditions at the site. The device should be installed slowly to minimize disturbance of the water in the casing and mixing of stagnant water above the screened interval with water in the screened interval. Following installation, the flow controller should be connected to the sample collection device and the flow-through cell connected to the outlet of the sample collection device. The calibrated groundwater chemistry monitoring probes should be installed in the flow-through cell. If a flow meter is used, it should be installed ahead of the flow-through cell.

If the well has a dedicated sample collection device, the controller for the sample collection device should be connected to the sample collection device. The flow meter and flow-through cell should be connected in line to the discharge tube, and the probes installed in the flow-through cell.

The controller should be activated and groundwater pumped (purged) from the well. The purge rate should be monitored, and should not exceed the capacity of the well. The well capacity is defined as the maximum discharge rate that can be obtained with less than 0.1-meter (0.3 foot) drawdown. Typically, the discharge rate will be less than 0.5 liters per minute (L/min) (0.13 gallon per minute [gpm]). The maximum purge rate should not exceed 1.0 L/min (0.25 gpm), and should be adjusted to achieve minimal drawdown.

Water levels, effluent chemistry, and effluent flow rate should be continuously monitored while purging the well. Purging should continue until the measured chemical and optical parameters are stable. Stable

parameters are defined as monitored chemistry values that do not fluctuate by more than the following ranges over three successive readings at 3-minute intervals: ± 0.1 pH unit; ± 3 percent for SC; ± 10 mV for Eh; and ± 10 percent for turbidity and DO. At a minimum, two times the internal volume of the pump (typically, 300 milliliters) and the pump tubing (9.7 milliliters per foot of standing water) must be purged. Purging will continue until the stabilization criteria have been met or three well borehole volumes have been purged (see SOP No. 002 for appropriate volume). If three borehole volumes of water have been purged and the stabilization criteria have not been met, a comment should be made on the data sheet that sample collection began before the groundwater had stabilized. The final pH, SC, Eh, turbidity, and DO values will be recorded. All data should be recorded on the Low-flow Groundwater Sampling Data Sheet attached to this SOP (or equivalent).

2.3 SAMPLE COLLECTION

Following purging, the flow through cell should be disconnected, and groundwater samples collected directly from the discharge line. Discharge rates should be adjusted so that groundwater is dispensed into the sample container with minimal aeration of the sample. Samples collected for volatile organic compound analysis should be dispensed into the sample container at a flow rate equal to or less than 0.1 L/min. Samples should be preserved and handled as described in the project-specific field sampling plan.

ATTACHMENT A
MONITORING WELL SAMPLING LOG (LOW-FLOW)



Monitoring Well Sampling Log (Low Flow)

MWO#: _____ Project/Site Name: _____ Date: _____ Well ID: _____

Casing Diameter:	
Well Data:	
Initial Measurements & Calculations:	
Equipment Documentation:	

Casing Diameter:	_____
Borehole Diameter:	_____
Depth of Casing (ft bTOC):	_____
Screen Interval (ft bTOC):	_____
Pump Intake (ft bTOC):	_____
Well Condition (Comments):	_____
Weather (temp/pressure/wind):	_____

Initial PID Reading at TOC (ppm):	_____
Depth to Product (ft bTOC; NA if none):	_____
Product Thickness (ft bTOC):	_____
Static Depth to Water (ft bTOC):	_____
Standing Water Column (ft):	_____
a) One Pump Volume (mL):	300 mL
b) One Tube Volume (mL):	ft x (9.7 ml/ft)= _____ mL
c) One Purge Volume (=a+b):	_____ mL
Minimum Volume to be Purged (=2xc):	_____ mL

Water Level Meter:	_____
Product Probe/Sampler (NA if none):	_____
Multi-Parameter Meter:	_____
PID:	_____
Purge/Sample Pumps:	_____
Control Box Settings:	_____
Pressure (psi):	_____
Fill Cycle (sec):	_____
Pump Cycle (sec):	_____

All measurements taken from the surveyor mark of top of casing.

Water Level Meter: _____

Product Probe/Sampler (NA if none): _____

Multi-Parameter Meter: _____

PID: _____

Purge/Sample Pumps: _____

Control Box Settings: _____

Pressure (psi): _____

Fill Cycle (sec): _____

Pump Cycle (sec): _____

All measurements taken from the surveyor mark at top of casing, or north side if no mark exists.

[illegible]

Purge Information:

Purge Method (circle one):	Marshall System / Aquarius / Bladder Pump
Time Purging Began:	
Total Milliliters Purged:	
Total Pump/Tubing Volumes Purged:	
Time Purging Completed:	

Sampling Information:

Sampling QA/QC Requirements (circle one):	NA	Dup/Split	MS/MSD
Sampling Method:			
Time Sampling Began:			
Filter Type (size/brand):	NA / QEC (0.45 micron) / Other:		
Amount Flushed Through Filter (well water in mL):			
Time Sampling Completed:			

SOP APPROVAL FORM

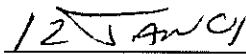
**THE PRESIDIO TRUST
ENVIRONMENTAL STANDARD OPERATING PROCEDURE**

SOIL GAS SAMPLING METHODS

**SOP NO. 011
REVISION NO. 00**

Last Reviewed: December 2000


Quality Assurance Approved


Date

1.0 BACKGROUND

Soil gas samples are collected in environmental investigations to assess the vapor phase of contaminants in the vadose zone (soil gas) or other gaseous constituents of interest. Soil gas samples can be collected using several methods. This standard operating procedure (SOP) presents sample collection procedures for collecting soil gas samples in Tedlar[®] bags, glass sampling bulbs, and stainless-steel canisters. Tedlar[®] bags and glass sampling bulbs are best suited for on-site or near-site chemical analysis, whereas steel canisters are best suited for shipping samples to a full service laboratory.

1.1 PURPOSE

The purpose of this SOP is to provide guidance for the use of Tedlar[®] bags, glass sampling bulbs, and stainless-steel canisters for soil gas sample collection. Soil gas samples collected by these methods may be analyzed for volatile organic compounds (such as trichloroethene, benzene, and toluene) and for inorganic parameters (such as nitrogen, oxygen, and carbon dioxide).

1.2 SCOPE

This SOP applies to all personnel collecting soil gas samples in Tedlar[®] bags, glass sampling bulbs, or stainless-steel canisters. The site-specific work and sampling plans should be followed during soil gas sampling activities.

1.3 DEFINITIONS

Soil Gas: The gases or atmosphere filling the void spaces in soils and unconsolidated sediments. These gases may all be of natural origin, but manmade contaminants or by-products may be present in detectable quantities.

Tedlar[®] Bag: Inflatable bag manufactured from proprietary non-reactive synthetic material impermeable to gases.

1.4 REFERENCES

American Society for Testing Materials (ASTM). 1993. "Standard Guide for Soil Gas Monitoring in the Vadose Zone." *Environmental Standards on Environmental Sampling*. Second Edition. 1997. ASTM D 5314-92. January.

U.S. Environmental Protection Agency (EPA). 1984. *Characterization of Hazardous Waste Sites – A Methods Manual: Volume II, Available Sampling Methods*. Second Edition. EPA-600/4-84-076. December.

EPA. 1988. *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air*. Method TO-14. Atmospheric Research and Exposure Assessment Laboratory. Research Triangle Park, North Carolina. EPA-600/4-89/017. June.

EPA. 1990. "General Precautions in the Use of Canister Sampling for Measuring VOCs in Ambient Air." Office of Solid Waste and Emergency Response. Bulletin Board.

1.5 REQUIREMENTS AND RESOURCES

When using the Tedlar[®] bag collection method, the following items are needed:

- A sampling port and attached sampling line, ready for sampling
- A pump (SKC universal flow pump or equivalent), capable of pumping at least 3 liters per minute to allow purging of the sample point prior to collection of soil gas samples
- Sampling lines (dedicated, 0.375-inch outer diameter Tygon[®] tubing) to connect all field equipment
- "Y"-branched plastic (Teflon[®]-lined if available) sampling hose for duplicate collection
- 500-cubic-centimeter (cm³) Tedlar[®] bags, with metal fittings
- Vacuum chamber

When using glass sampling bulbs to collect soil gas, the following items are needed:

- A supply of clean 250- or 500-milliliter (mL) glass gas sampling bulbs with stopcock valves
- Tygon[®] tubing or equivalent of appropriate size to connect the sampling bulb to the sample port and vacuum system
- A vacuum pump to purge the sampling system and to allow for sample collection. A vacuum/volume system capable of measuring purge volumes is desirable.
- A sampling system with an inline pressure gauge
- A source of heated air to purge and decontaminate the reusable glass sampling bulbs prior to initial use and between each subsequent use. This may consist of a simple hand-held hair drier.

When using steel canisters to collect soil gas, the following items are needed:

- A supply of clean, evacuated stainless-steel canisters (SUMMA[®] canisters) with a pressure gauge to verify internal pressure
- A vacuum pump (SKC universal flow pump or equivalent) to allow purging of the sample point prior to collection of soil gas samples
- Tygon[®] tubing or equivalent of appropriate size for connecting the sampling port to pump (during gas point purging) and the sampling port to stainless steel canister (during sample collection)
- Y-branched tubing (plastic, Teflon[®]-lined if available) for duplicate collection

2.0 PROCEDURES

This section describes selection of soil gas sampling locations and general preparation of the sampling system to be used. This section also provides detailed procedures for collecting samples using Tedlar[®] bags, glass bulbs, and stainless-steel canisters. Finally, this section discusses additional considerations that affect soil gas sampling (including duplicate and equipment blank sample collection, decontamination, and sample transfer) and summarizes the advantages and disadvantages of each sampling method.

2.1 SAMPLING LOCATION SELECTION

Sampling locations should be selected and prepared for sampling as described in a project-specific field sampling plan (FSP). Soil gas samples may be collected from depths as shallow as 3 feet or as great as 50 feet, depending on the objectives of the project, the site soil conditions, and the specific equipment used to penetrate to depth.

2.2 SAMPLING SYSTEM PREPARATION

Typical sample probe assemblies may consist of three types: (1) a hand-driven soil gas probe 4 feet in length, (2) a drill rig-driven soil gas probe 2 feet in length, and (3) a hydraulic-driven soil gas probe 3 feet in length. The probes may be assembled in series to reach the desired sampling depth. The probes will be driven to or emplaced at the desired sample collection depth, and then fitted with the Tygon[®] sampling line.

Once fitted with the sampling line, the ambient air within the sampling system is purged. Usually, three system volumes are purged prior to sample collection. If the sampling system purge volume cannot be measured, then a standard purge time of 3 to 5 minutes should be used.

After the system is purged of ambient air but before the pump is turned off, about 2 inches of the sampling line closest to the entrance port of the pump should be folded over itself and the tubing should be clamped to keep ambient air from reentering the system. This is not necessary when sampling with glass bulbs because the bulbs are already connected to the sampling line. After the system is purged and sealed to ambient air, the pump should be turned off. Sample collection can now proceed using a Tedlar® bag, a glass bulb, or a stainless-steel canister.

2.3 SAMPLE COLLECTION USING TEDLAR® BAGS

Soil gas can be collected for chemical analysis in a 500-cm³ Tedlar® gas sampling bag. This can be accomplished by using an SKC pump to induce a vacuum on the exterior of the bag. This will cause the Tedlar® bag to be inflated with soil gas. The following procedure should be used:

1. Connect the free end of the Tygon® tubing (previously inserted through the top of the vacuum chamber) to the Tedlar® gas sampling bag. Open the valve on the gas sampling bag and place the tubing into the body of the vacuum chamber.
2. Place the top on the vacuum chamber.
3. Connect the free end of the evacuation tube to the SKC pump.
4. Turn on the pump. This should create a vacuum in the chamber, and the Tedlar® bag should fill at a rate of approximately 2 liters per minute. The rate at which the Tedlar® gas sampling bag fills will depend on the porosity and permeability of the soil.
5. The minimum amount of soil gas needed for analysis is approximately 0.25 liter.
6. If less than 0.25 liter is collected after 4 minutes of sampling, raise the soil gas probe 0.5 foot (if possible). Continue to evacuate the vacuum chamber for another minute. If the minimum required soil gas is not collected, repeat the procedure again. If the minimum required volume of soil gas is still not collected, abandon the collection process. All steps conducted are to be accurately recorded in the field logbook.
7. Remove the top of the vacuum chamber after the soil gas sample is collected in the Tedlar® bag.
8. Close the valve on the Tedlar® gas sampling bag, clamp the Tygon® tubing, and remove the Tedlar® gas sampling bag.

9. Turn off the pump.
10. Label the Tedlar® bag and its corresponding field datasheet (see Attachment A) with the sample number. An alternative documentation procedure is to enter the requisite information in the field logbook. Fill out the rest of the field datasheet.

2.4 SAMPLE COLLECTION USING GLASS BULBS

Soil gas also can be collected for chemical analysis in a glass bulb. When this sampling method is used, the glass bulb must be connected to the sampling system and purged of ambient air along with the sampling line before the sample is collected. The system is purged and the sample is collected using the following procedure:

1. Connect one end of the glass bulb to the sample line and the other end of the glass bulb to the vacuum pump using Tygon® tubing, and then open both stopcocks on the bulb.
2. Turn on the vacuum pump and purge the sampling system as discussed in Section 2.2.
3. Turn off the vacuum pump.
4. Observe the inline pressure gauge to determine when the vacuum in the bulb has been filled with soil gas. This may require several minutes, particularly in soils with low porosity and permeability. If the vacuum in the bulb has not dropped after 4 minutes of sampling, raise the soil gas probe in 0.5-foot increments in an attempt to find a more permeable zone. If the soil gas probe is moved, guard against leakage of ambient air into the system and repurge if necessary.
5. Once the vacuum in the gas sampling bulb has been filled, close off the upstream stopcock on the bulb, then the downstream stopcock and disconnect the bulb from the sample line.
6. Label the glass bulb and its corresponding field datasheet (see Attachment A) with the sample number. An alternative documentation procedure is to enter the requisite information in the field logbook. Fill out the rest of the field datasheet.

2.5 SAMPLE COLLECTION USING STAINLESS-STEEL CANISTERS

Soil gas also can be collected for chemical analysis in a stainless-steel, evacuated canister. Often, these canisters are used to collect duplicate samples for off-site analysis from locations that are being sampled for field screening analysis using Tedlar® bags or glass bulbs.

When this method is used, the canister is connected directly to the purged Tygon® sampling tube. To prevent ambient air from entering the canister during sample collection, all connections must be airtight. To collect soil gas samples using this method, the following procedure is used:

1. Measure the canister pressure reading, ambient air temperature, and ambient air pressure, and record the readings in the field logbook before sample collection.
2. Open the canister pressure valve, which will allow the evacuated stainless-steel canister to draw in soil gas until the canister reaches ambient pressure. When the sampling valve on the canister shows that ambient pressure has been reached, close the sampling valve and remove the canister from the sampling line.
3. Measure and record the post-sampling pressure reading on the canister pressure valve.
4. Label the canister and its corresponding field datasheet (see Attachment A) with the sample number. An alternative documentation procedure is to enter the requisite information in the field logbook. Fill out the rest of the field datasheet.

2.6 DUPLICATE AND EQUIPMENT BLANK COLLECTION

Duplicate soil gas samples will be collected at each site as required in the project-specific FSP. Generally, one duplicate sample will be collected for every ten samples collected. Each duplicate is collected in conjunction with a corresponding environmental sample.

To collect duplicate samples, a Y-branched sampling hose will be connected to the vacuum chamber or pump. Two Tedlar® bags, glass bulbs, or stainless-steel canisters will be attached, one to each end of the Y-branched hose. Sample collection will proceed as described above. After collection, one sample will be labeled as the environmental sample and one as the duplicate.

Equipment blanks also will be collected at each site as required in the project-specific FSP. Generally, one blank will be collected for every ten samples collected. Blanks will be collected by running ambient air through the sampling system immediately after it has been decontaminated, and by collecting the ambient air in a Tedlar® bag, glass bulb, or stainless-steel canister using the same procedures used to collect environmental samples. Blank sample collection is conducted upwind of any observed interference, and the location of the sampling should be recorded in the field logbook. Equipment blanks are collected to ensure that field equipment decontamination procedures are adequate.

2.7 DECONTAMINATION

Sampling probes should be decontaminated before the first sample is collected and between sampling points. Probes that are grossly contaminated should be decontaminated using a high-pressure steam cleaner. Probes that are not grossly contaminated can be decontaminated by brushing off loose soil particles, then heating the probes until they are warm to the touch to drive off any volatile contaminants. Heating times of 7 to 10 minutes are generally sufficient for this purpose. This brushing and heating method greatly reduces the generation of decontamination fluids.

Glass sampling bulbs also must be decontaminated between each use. This may be accomplished by purging heated air through the bulbs using a hand-held hair drier and the vacuum pump. Highly contaminated bulbs may require decontamination using either a methanol or soapy water wash and a deionized water rinse.

If Y-branched tubing or any other sampling equipment is to be reused, it must also be decontaminated between sampling locations.

2.8 SAMPLE TRANSFER

After collection, each sample container will be transported to the designated laboratory for analysis. In many cases, samples will be analyzed on site in a mobile laboratory.

2.9 ADVANTAGES AND DISADVANTAGES OF EACH SAMPLING METHOD

Tedlar® bags are relatively inexpensive to use but can only be used once and then must be disposed of. If the soil formation being sampled has a low porosity and permeability, such as clay or silty clay, it may not be possible to fully inflate the Tedlar® bag with soil gas.

Glass bulbs are more expensive than Tedlar® bags but they can be reused indefinitely, as long as they are not broken. However, bulbs must be decontaminated between each use, and periodic equipment blanks must be analyzed to verify that the decontamination procedures used are effective.

Stainless-steel canisters are very expensive and, therefore, are not cost-effective when conducting on-site analysis. The advantage of this type of sampler is that confirmation samples may be collected and shipped off-site for analysis with excellent assurance of sample integrity.

3.0 PRECAUTIONS

Both Tedlar® bags and glass bulbs are transparent to light, and many volatile compounds are subject to degradation in sunlight. As a result, samples should be stored in a dark place, such as a cooler, and analyzed as quickly as possible. In general, samples collected in Tedlar® bags or glass bulbs should be analyzed within 24 hours after collection, at a maximum. This will ensure sample integrity and minimize contaminant loss by degradation processes or absorption onto surfaces.

The concentration of volatile organic contaminants in the vapor phase in soil gas is a function of many complex and dynamic variables. Soil gas results do not usually show a direct correlation to groundwater contamination. However, soil gas may reflect to groundwater contaminant conditions and can be a useful tool for locating sources of volatile organic contamination in groundwater quickly and inexpensively.

While sampling, each sampling location should be screened with a flame ionization detector (FID) or photoionization detector (PID) following sample collection. The result of the FID or PID screening should be recorded on the sample container and field sheet so that the chemist analyzing the sample can determine whether sample dilutions or smaller sample volumes are required for analysis.

ATTACHMENT A
FIELD DATASHEET FOR SOIL GAS SAMPLING METHODS



FIELD DATASHEET FOR SOIL GAS SAMPLING METHODS

Date: _____ Project/Site Name: _____

Time: _____ MWO No.: _____

Sample Container: _____ Tedlar® Bag: _____ Glass Bulb: _____ SUMMA® Canister: _____

Sampling Location and Depth: _____

Description of Location: _____

Sample Location Purged: Yes _____ FID or PID (circle one) Reading: _____

Sample Relinquished By: _____ Date/Time: _____

Sample Received By: _____ Date/Time: _____

Attach field copy of sample label or write in sample number.

Notes:

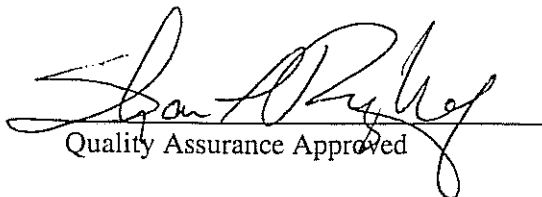
SOP APPROVAL FORM

**THE PRESIDIO TRUST
ENVIRONMENTAL STANDARD OPERATING PROCEDURE**

GENERAL EQUIPMENT DECONTAMINATION

**SOP NO. 014
REVISION NO. 00**

Last Reviewed: December 2000


Quality Assurance Approved

12 Jan 01
Date

1.0 BACKGROUND

All nondisposable field equipment must be decontaminated before and after each use at each sampling location to obtain representative samples and to reduce the possibility of cross-contamination.

1.1 PURPOSE

This standard operating procedure (SOP) establishes the requirements and procedures for decontaminating equipment in the field.

1.2 SCOPE

This SOP applies to decontaminating general nondisposable field equipment. To prevent contamination of samples, all sampling equipment must be thoroughly cleaned prior to each use.

1.3 DEFINITIONS

Nonphosphate soap: Alconox[®] and Liquinox[®] are common laboratory grade products

1.4 REFERENCES

U.S. Environmental Protection Agency (EPA). 1992. "RCRA Groundwater Monitoring: Draft Technical Guidance." Office of Solid Waste and Emergency Response. Washington, DC. EPA/530-R-93-001. November.

EPA. 1994. "Sampling Equipment Decontamination." Environmental Response Team SOP No. 2006. Revision No. 0.0. August 11. (On-Line Address: http://www.ert.org/media_resrcs/media_resrcs.asp.)

1.5 REQUIREMENTS AND RESOURCES

The equipment required to conduct decontamination is as follows:

- Scrub brushes
- Large wash tubs or buckets
- Squirt bottles
- Nonphosphate soap
- Tap water

- Distilled water
- Plastic sheeting
- Aluminum foil
- Methanol or hexane
- Dilute (0.1 N) nitric acid
- Steam cleaner

2.0 PROCEDURES

The procedures below discuss decontamination of personal protective equipment (PPE), drilling and monitoring well installation equipment, borehole soil sampling equipment, water-level measurement equipment, and general sampling equipment.

2.1 PERSONAL PROTECTIVE EQUIPMENT DECONTAMINATION

Personnel working in the field are required to follow specific procedures for decontamination prior to leaving the work area so that contamination is not spread off-site or to clean areas. All used disposable protective clothing, such as Tyvek® coveralls, gloves, and booties, will be containerized for later disposal. Decontamination water will be containerized in 55-gallon drums.

Personnel decontamination procedures will be as follows:

1. Wash neoprene boots (or neoprene boots with disposable booties) with Liquinox or Alconox solution and rinse with clean water. Remove booties and retain boots for subsequent reuse.
2. Wash outer gloves in Liquinox® or Alconox® solution and rinse in clean water. Remove outer gloves and place into plastic bag for disposal.
3. Remove Tyvek® or coveralls. Containerize Tyvek® for disposal and place coveralls in plastic bag for reuse.
4. Remove air purifying respirator (APR), if used, and place the spent filters into a plastic bag for disposal. Filters should be changed daily or sooner depending on use and application. Place respirator into a separate plastic bag after cleaning and disinfecting.
5. Remove disposable gloves and place them in plastic bag for disposal.
6. Thoroughly wash hands and face in clean water and soap.

2.2 DRILLING AND MONITORING WELL INSTALLATION EQUIPMENT DECONTAMINATION

All drilling equipment should be decontaminated before drilling operations begin, between borings, and at completion of the project. The locations for decontamination activities will be designated by the Trust project manager.

Monitoring well casing, screens, and fittings are assumed to be delivered to the site in a clean condition. However, they should be steam cleaned on-site prior to placement downhole. The drilling subcontractor will typically furnish the steam cleaner and water.

After cleaning the drilling equipment, field personnel should place the drilling equipment, well casing and screens, and any other equipment that will go into the hole on clean polyethylene sheeting. The drilling auger, bits, drill pipe, temporary casing, surface casing, and other equipment should be decontaminated by the drilling subcontractor by hosing down with a steam cleaner until thoroughly clean. Drill bits and tools that still exhibit particles of soil after the first washing should be scrubbed with a wire brush and then rinsed again with a high-pressure steam rinse.

All wastewater from decontamination procedures should be containerized.

2.3 BOREHOLE SOIL SAMPLING EQUIPMENT DECONTAMINATION

The soil sampling equipment should be decontaminated after each sample as follows:

1. Prior to sampling, scrub the split-barrel sampler and sampling tools in a bucket, containing Liquinox[®] or Alconox[®] solution, using a stiff, long bristle brush.
2. Steam clean the sampling equipment over the rinsate tub and allow to air dry or rinse with deionized (distilled) water.
3. Place cleaned equipment in a clean area on plastic sheeting and wrap with aluminum foil.
4. Containerize all water and rinsate.
5. Decontaminate all pipe placed down the hole as described for drilling equipment.

2.4 WATER-LEVEL MEASUREMENT EQUIPMENT DECONTAMINATION

Field personnel should decontaminate the well sounder and interface probe before inserting and after removing them from each well. The following decontamination procedures should be used:

1. Wipe the sounding cable with a disposable soap-impregnated cloth or paper towel.
2. Rinse with deionized (distilled) organic-free water.

2.5 GENERAL SAMPLING EQUIPMENT DECONTAMINATION

All nondisposable sampling equipment should be decontaminated using the following procedures:

1. Select an area removed from sampling locations that is both downwind and downgradient. Decontamination must not cause cross-contamination between sampling points.
2. Maintain the same level of protection as was used for sampling.
3. If a steam cleaner is not available, to decontaminate a piece of equipment, use an Alconox[®] wash; a tap water wash; a solvent (methanol or hexane) rinse, if applicable or dilute (0.1 N) nitric acid rinse, if applicable; a distilled water rinse; and air drying. Use a solvent (methanol or hexane) rinse for grossly contaminated equipment (for example, equipment that is not readily cleaned by the Alconox[®] wash). The dilute nitric acid rinse may be used if metals are the analyte of concern.
4. Place cleaned equipment in a clean area on plastic sheeting and wrap with aluminum foil.
5. Containerize all water and rinsate.

SOP APPROVAL FORM

**THE PRESIDIO TRUST
ENVIRONMENTAL STANDARD OPERATING PROCEDURE**

PACKAGING AND SHIPPING SAMPLES

**SOP NO. 015
REVISION NO. 00**

Last Reviewed: December 2000


Quality Assurance Approved

12 JAN 01
Date

1.0 BACKGROUND

In any sampling program, the integrity of a sample must be ensured from its point of collection to its final disposition. Procedures for classifying, packaging, and shipping samples are described below. Steps in the procedures should be followed to ensure sample integrity and to protect the welfare of persons involved in shipping and receiving samples. When hazardous substances and dangerous goods are sent by common carrier, their packaging, labeling, and shipping are regulated by the U.S. Department of Transportation (DOT) Hazardous Materials Regulations (HMR) (*Code of Federal Regulations*, Title 49 [49 CFR] Parts 106 through 180) and the International Air Transportation Association (IATA) Dangerous Goods Regulations (DGR).

1.1 PURPOSE

This standard operating procedure (SOP) establishes the requirements and procedures for packaging and shipping samples. It has been prepared in accordance with the U.S. Environmental Protection Agency (EPA) “Sampler’s Guide to the Contract Laboratory Program (CLP),” the DGR, and the HMR. Sample packaging and shipping procedures described in this SOP should be followed for all sample packaging and shipping. Deviations from the procedures in this SOP must be documented in a field logbook. This SOP assumes that samples are already collected in the appropriate sample jars and that the sample jars are labeled and tagged appropriately.

1.2 SCOPE

This SOP applies to sample classification, packaging, and shipping.

1.3 DEFINITIONS

Chain of Custody: Document indicating custody of the samples at all times between sampling and analysis.

Custody Seal: A custody seal is a tape-like seal. Placement of the custody seal is part of the chain-of-custody process and is used to prevent tampering with samples after they have been packaged for shipping.

Dangerous Goods: Dangerous goods are articles or substances that can pose a significant risk to health, safety, or property when transported by air; they are classified as defined in Section 3 of the DGR (IATA 1999).

Environmental Samples: Environmental samples include drinking water, groundwater and surface water, soil, sediment, treated municipal and industrial wastewater effluent, and biological specimens. Environmental samples typically contain low concentrations of contaminants and when handled require only limited precautionary procedures.

Hazardous Materials Regulations: The HMRs are DOT regulations for the shipment of hazardous materials by air, water, and land; they are located in 49 CFR 106 through 180.

Hazardous Samples: Hazardous samples include dangerous goods and hazardous substances. Hazardous samples shipped by air should be packaged and labeled in accordance with procedures specified by the DGR; ground shipments should be packaged and labeled in accordance with the HMR.

Hazardous Substance: A hazardous substance is any material, including its mixtures and solutions, that is listed in Appendix A of 49 CFR 172.101 and its quantity, in one package, equals or exceeds the reportable quantity (RQ) listed in the appendix.

IATA Dangerous Goods Regulations: The DGRs are regulations that govern the international transport of dangerous goods by air. The DGRs are based on the International Civil Aviation Organization (ICAO) Technical Instructions. The DGR contain all of the requirements of the ICAO Technical Instructions and are more restrictive in some instances.

Nonhazardous Samples: Nonhazardous samples are those samples that do not meet the definition of a hazardous sample and **do not** need to be packaged and shipped in accordance with the DGR or HMR.

Overpack: An enclosure used by a single shipper to contain one or more packages and to form one handling unit (IATA 1999). For example, a cardboard box may be used to contain three fiberboard boxes to make handling easier and to save on shipping costs.

1.4 REFERENCES

- U.S. Department of Transportation, Transport Canada, and the Secretariat of Communications and Transportation of Mexico (DOT and others). 1996. *1996 North American Emergency Response Guidebook*.
- International Air Transport Association (IATA). 1997. *Guidelines for Instructors of Dangerous Courses*.
- IATA. 1999. *Dangerous Goods Regulations*. 40th Edition.
- U.S. Environmental Protection Agency. 1994. "Sampler's Guide to the Contract Laboratory Program." Office of Solid Waste and Emergency Response. Washington, DC. EPA/540/R-96/032. On-Line Address: <http://www.epa.gov/oerrpage/superfund/programs/clp/guidance.htm> - sample

1.5 REQUIREMENTS AND RESOURCES

The procedures for packaging and shipping **nonhazardous** samples require the following:

- Coolers
- Ice
- Vermiculite, bubble wrap, or similar cushioning material
- Chain-of-custody forms and seals
- Airbills
- Resealable plastic bags for sample jars and ice
- Tape (strapping and clear)

The procedures for packaging and shipping **hazardous** samples require the following:

- Ice
- Vermiculite or other noncombustible, absorbent packing material
- Chain-of-custody forms and seals
- Appropriate dangerous goods airbills and emergency response information to attach to the airbill
- Resealable plastic bags for sample jars and ice

- Tape (strapping and clear)
- Appropriate shipping containers, as specified in the DGR
- Labels that apply to the shipment such as hazard labels, address labels, “Cargo Aircraft Only” labels, and package orientation labels (up arrows)

2.0 PROCEDURES

The following procedures apply to packing and shipping nonhazardous and hazardous samples.

2.1 SAMPLE CLASSIFICATION

Prior to sample shipment by air courier, it must be determined whether the sample is subject to the DGR. Samples subject to these regulations shall be referred to as hazardous samples. Any airline belonging to IATA must follow the DGR. As a result, these air carriers **may not** accept a shipment that is packaged and labeled in accordance with the HMR (although in most cases, the packaging and labeling would be the same for either set of regulations). The HMR states that a hazardous material may be transported by aircraft in accordance with the ICAO Technical Instruction (49 CFR 171.11) upon which the DGR is based. Therefore, the use of the DGR for samples to be shipped by air complies with the HMR, but not vice versa.

Most environmental samples are not hazardous samples and do not need to be packaged in accordance with any regulations. Hazardous samples are those samples that can be classified as specified in Section 3 of the DGR, can be found in the List of Dangerous Goods in the DGR in bold type, are considered a hazardous substance (see definition), or are mentioned in “Section 2 - Limitations” of the DGR for countries of transport or airlines (such as FedEx). The hazard classifications specified in the DGR (and the HMR) are as follows:

Class 1 – Explosives

- Division 1.1 – Articles and substances having a mass explosion hazard
- Division 1.2 – Articles and substances having a projection hazard but not a mass explosion hazard
- Division 1.3 – Articles and substances having a fire hazard, a minor blast hazard, and/or a minor projection hazard but not a mass explosion hazard
- Division 1.4 – Articles and substances presenting no significant hazard
- Division 1.5 – Very sensitive substances mass explosion hazard

Division 1.6 – Extremely insensitive articles, which do not have a mass explosion hazard

Class 2 – Gases

Division 2.1 – Flammable gas

Division 2.2 – Nonflammable, nontoxic gas

Division 2.3 – Toxic gas

Class 3 – Flammable Liquids

Class 4 – Flammable Solids; Substances Liable to Spontaneous Combustion; Substances, when in Contact with Water, Emit Flammable Gases

Division 4.1 – Flammable solids

Division 4.2 – Substances liable to spontaneous combustion

Division 4.3 – Substances, when in contact with water, emit flammable gases

Class 5 – Oxidizing Substances and Organic Peroxide

Division 5.1 – Oxidizers

Division 5.2 – Organic peroxides

Class 6 – Toxic and Infectious Substances

Division 6.1 – Toxic substances

Division 6.2 – Infectious substances

Class 7 – Radioactive Material

Class 8 – Corrosives

Class 9 – Miscellaneous Dangerous Goods

The criteria for each of the first eight classes are very specific and are outlined in Section 3 of the DGR and 49 CFR 173 of the HMR. Some classes and divisions are further divided into packing groups based on their level of danger. Packing group I indicates a great danger, packing group II indicates a medium danger, and packing group III indicates a minor danger. Class 2, gases, includes any compressed gas being shipped and any noncompressed gas that is either flammable or toxic. A compressed gas is defined as having a pressure over 40 pounds per square inch (psi) absolute (25 psi gauge). Most air samples and empty cylinders that did not contain a flammable or toxic gas are exempt from the regulations. An empty hydrogen cylinder, as in a flame ionization detector (FID), is considered a dangerous good unless it is properly purged with nitrogen in accordance with the HMR. A landfill gas sample is usually considered a

flammable gas because it may contain a high percentage of methane. Class 3, flammable liquids, are based on the boiling point and flash point of a substance. Most class 3 samples include solvents, oil, gas, or paint-related material collected from drums, tanks, or pits. Division 6.1, toxic substances, is based on oral toxicity (LD₅₀ [lethal dose that kills 50 percent of the test animals]), dermal toxicity (LD₅₀ values), and inhalation toxicity (LC₅₀ [lethal concentration that kills 50 percent of the test animals] values). Division 6.1 substances include pesticides and cyanide. Class 7, radioactive material, is defined as any article or substance with a specific activity greater than 70 kiloBecquerels (kBq/kg) (0.002 [microCuries per gram [μCi/g])). If the specific activity exceeds this level, the sample should be shipped in accordance with Section 10 of the DGR. Class 8, corrosives, is based on the rate at which a substance destroys skin tissue or corrodes steel; they are not based on pH. Class 8 materials include the concentrated acids used to preserve water samples. Preserved water samples are not considered class 8 substances and should be packaged as nonhazardous samples. Class 9, miscellaneous dangerous goods, is substances that present a danger, but are not covered by any other hazard class. Examples of class 9 substances include asbestos, polychlorinated biphenyls (PCB), and dry ice.

Unlike the DGR, the HMR includes combustible liquids in hazard class 3. The definition of a combustible liquid is specified in 49 CFR 173.120 of the HMR. The HMR has an additional class, ORM-D, which is not specified in the DGR. “ORM-D material” refers to a material such as a consumer commodity, which although otherwise subject to the HMR, presents a limited hazard during transport due to its form, quantity, and packaging. It must be a material for which exceptions are provided in the table of 49 CFR 172.101. The DGR lists consumer commodities as a class 9 material.

In most instances, the hazard of a material sampled is unknown because no laboratory testing has been conducted. A determination as to the suspected hazard of the sample must be made using knowledge of the site, field observations, field tests, and other available information.

According to 40 CFR 261.4(d) and (e), samples transported to a laboratory for testing or treatability studies, including samples of hazardous wastes, are **not** hazardous wastes. Air carriers will not accept a shipment of hazardous waste.

2.2 PACKAGING NONHAZARDOUS SAMPLES

Nonhazardous samples, after being appropriately containerized, labeled, and tagged, should be packaged in the following manner.

1. Place the sample in a resealable plastic bag.
2. Place the bagged sample in a cooler and pack it to prevent breakage.
3. Prevent breakage of bottles during shipment by either wrapping the sample container in bubble wrap, or lining the cooler with a noncombustible material such as vermiculite. Vermiculite is especially recommended because it will absorb any free liquids inside the cooler. It is recommended that the cooler be lined with a large plastic garbage bag before samples, ice, and absorbent packing material are placed in the cooler.
4. Add a sufficient quantity of ice to the cooler to cool samples to 4 °C. Ice should be double bagged in resealable plastic bags to prevent the melted ice from leaking out. As an option, a temperature blank (a sample bottle filled with distilled water) can be included with the cooler.
5. Seal the completed chain-of-custody forms in a plastic bag and tape the plastic bag to the inside of the cooler lid.
6. Tape any instructions for returning the cooler to the inside of the lid.
7. Close the lid of the cooler and tape it shut by wrapping strapping tape around both ends and hinges of the cooler at least once. Tape shut any drain plugs on the cooler.
8. Place two signed custody seals on the cooler, ensuring that each one covers the cooler lid and side of the cooler. Place clear plastic tape over the custody seals.
9. Place address labels on the outside of the cooler, if samples are to be shipped by a commercial carrier.

2.2 PACKAGING HAZARDOUS SAMPLES

Packaging of hazardous samples should only be performed by individuals with DOT shipping training. The procedures for packaging hazardous samples are summarized below. Note that according to the DGR, all spellings must be exactly as they appear in the List of Dangerous Goods, and only approved abbreviations are acceptable. The corresponding HMR regulations are provided in parentheses following any DGR references. The HMR must be followed only if shipping hazardous samples by ground transport.

1. Determine the proper shipping name for the material to be shipped. All proper shipping names are listed in column B of the List of Dangerous Goods table in Section 4 of the DGR (or column 2 of the Hazardous Materials Table in 49 CFR 172.101). In most instances, a generic name based on the hazard class of the material is appropriate. For example, a sample of an oily liquid collected from a drum with a high photoionization detector (PID) reading should be packaged as a flammable liquid. The proper shipping name chosen for this sample would be “flammable liquid, n.o.s.” The abbreviation “n.o.s.” stands for “not otherwise specified” and is used for generic shipping names. Typically, a specific name, such as acetone, should be inserted in parentheses after most n.o.s. descriptions. However, a technical name is not required when shipping a sample for testing purposes and the components are not known. If shipping a hazardous substance (see definition), then the letters “RQ” must appear in front of the proper shipping name.
2. Determine the United Nations (UN) identification number, class or division, subsidiary risk if any, required hazard labels, packing group, and either passenger aircraft or cargo aircraft packing instructions based on the quantity of material being shipped in one package. This information is provided in the List of Dangerous Goods (or Hazardous Materials Table in 49 CFR 172.101) under the appropriate proper shipping name. A “Y” in front of a packing instruction indicates a limited quantity packing instruction. If shipping dry ice or a limited quantity of a material, then UN specification shipping containers do not need to be used.
3. Determine the proper packaging required for shipping the samples. Except for limited quantity shipments and dry ice, these UN specification packages have been tested to meet the packing group of the material being shipped. Specific testing requirements of the packages are listed in Section 6 of the DGR (or 49 CFR 178 of the HMR). All UN packages are stamped with the appropriate UN specification marking. Prior planning is required to have the appropriate packages on hand during a sampling event where hazardous samples are anticipated. Most samples can be shipped in either a 4G fiberboard box, a 1A2 steel drum, or a 1H2 plastic drum. Drums can be purchased in 5- and 20-gallon sizes and are ideal for shipping multiple hazardous samples. When FedEx is used to ship samples containing PCBs, the samples must be shipped in an inner metal packaging (paint can) inside a 1A2 outer steel drum. This method of packaging PCB samples is in accordance with FedEx variation FX-06, listed in Section 2 of the DGR.
4. Place each sample jar in a separate resealable plastic bag. Some UN specification packages contain the sample jar and plastic bag to be used when shipping the sample.
5. Place each sealed bag inside the approved UN specification container (or other appropriate container if a limited quantity or dry ice) and pack with enough noncombustible, absorbent, cushioning material (such as vermiculite) to prevent breakage and to absorb liquid.
6. Place chain-of-custody forms in a resealable plastic bag and either attach it to the inside lid of the container or place it on top inside the container. Place instructions for returning the container to the shipper on the inside lid of the container as appropriate. Close and seal the shipping container in the manner appropriate for the type of container being used.

7. Label and mark each package appropriately. All irrelevant markings and labels need to be removed or obliterated. All outer packaging must be marked with proper shipping name, UN identification number, and name and address of the shipper and the recipient. For carbon dioxide, solid (dry ice), the net weight of the dry ice within the package needs to be marked on the outer package. For limited quantity shipments, the words “limited quantity” or “LTD. QTY.” must be marked on the outer package. Affix the appropriate hazard label to the outer package. If the material being shipped contains a subsidiary hazard, then a subsidiary hazard label must also be affixed to the outer package. The subsidiary hazard label is identical to the primary hazard label except that the class or division number is not present. It is acceptable to obliterate the class or division marking on a primary hazard label and use it as the subsidiary hazard label. If using cargo aircraft only packing instructions, then the “Cargo Aircraft Only” label must be used. Package orientation labels (up arrows) must be placed on opposite sides of the outer package. Figure 1 depicts a properly marked and labeled package.
8. If using an overpack (see definition), mark and label the overpack and each outer packaging within the overpack as described in step 7. In addition, the statement “INNER PACKAGES COMPLY WITH PRESCRIBED SPECIFICATIONS” must be marked on the overpack.
9. Attach custody seals, and fill out the appropriate shipping papers as described in Section 2.4.

2.4 SHIPPING PAPERS FOR HAZARDOUS SAMPLES

A “Shippers Declaration for Dangerous Goods” and “Air Waybill” must be completed for each shipment of hazardous samples. Air carriers generally supply a their own Dangerous Goods Airbill to their customers; the airbill typically combines both the declaration and the waybill. An example of a completed Dangerous Goods Airbill is depicted in Figure 2. A shipper’s declaration must contain the following:

- Name and address of shipper and recipient
- Air waybill number (not applicable to the HMR)
- Page ____ of ____
- Deletion of either “Passenger and Cargo Aircraft” or “Cargo Aircraft Only,” whichever does not apply
- Airport or city of departure
- Airport or city of destination
- Deletion of either “Non-Radioactive” or “Radioactive,” which ever does not apply

- The nature and quantity of dangerous goods. This includes the following information in the following order (obtained from the List of Dangerous Goods in the DGR): proper shipping name, class or division number, UN identification number, packing group number, subsidiary risk, quantity in liters or kilograms (kg), type of packaging used, packing instructions, authorizations, and additional handling information. Authorizations include the words “limited quantity” or “LTD. QTY.” if shipping a limited quantity, any special provision numbers listed in the List of Dangerous Goods in the DGR, and the variation “USG-14” when a technical name is required after the proper shipping name but not entered because it is unknown.
- Signature for the certification statement
- Name and title of signatory
- Place and date of signing certification
- A 24-hour emergency response telephone number for use in the event of an incident involving the dangerous good
- Emergency response information attached to the shipper’s declaration. This information can be in the form of a material safety data sheet or the applicable North American Emergency Response Guidebook (NAERG; DOT 1996) pages. Figure 3 depicts the appropriate NAERG emergency response information for “Flammable liquids, n.o.s.” as an example.

Note that dry ice does not require an attached shipper’s declaration. However, the air waybill must include the following on it: “Dry ice, 9, UN1845, ____ x ____ kg.” The blanks must include the number of packages and the quantity in kg in each package. If using FedEx to ship dry ice, the air waybill includes a box specifically for dry ice. Simply check the appropriate box and enter in the number of packages and quantity in each package.

The HMR requirements for shipping papers are located in 49 CFR 172 Subpart C.

3.0 POTENTIAL PROBLEMS

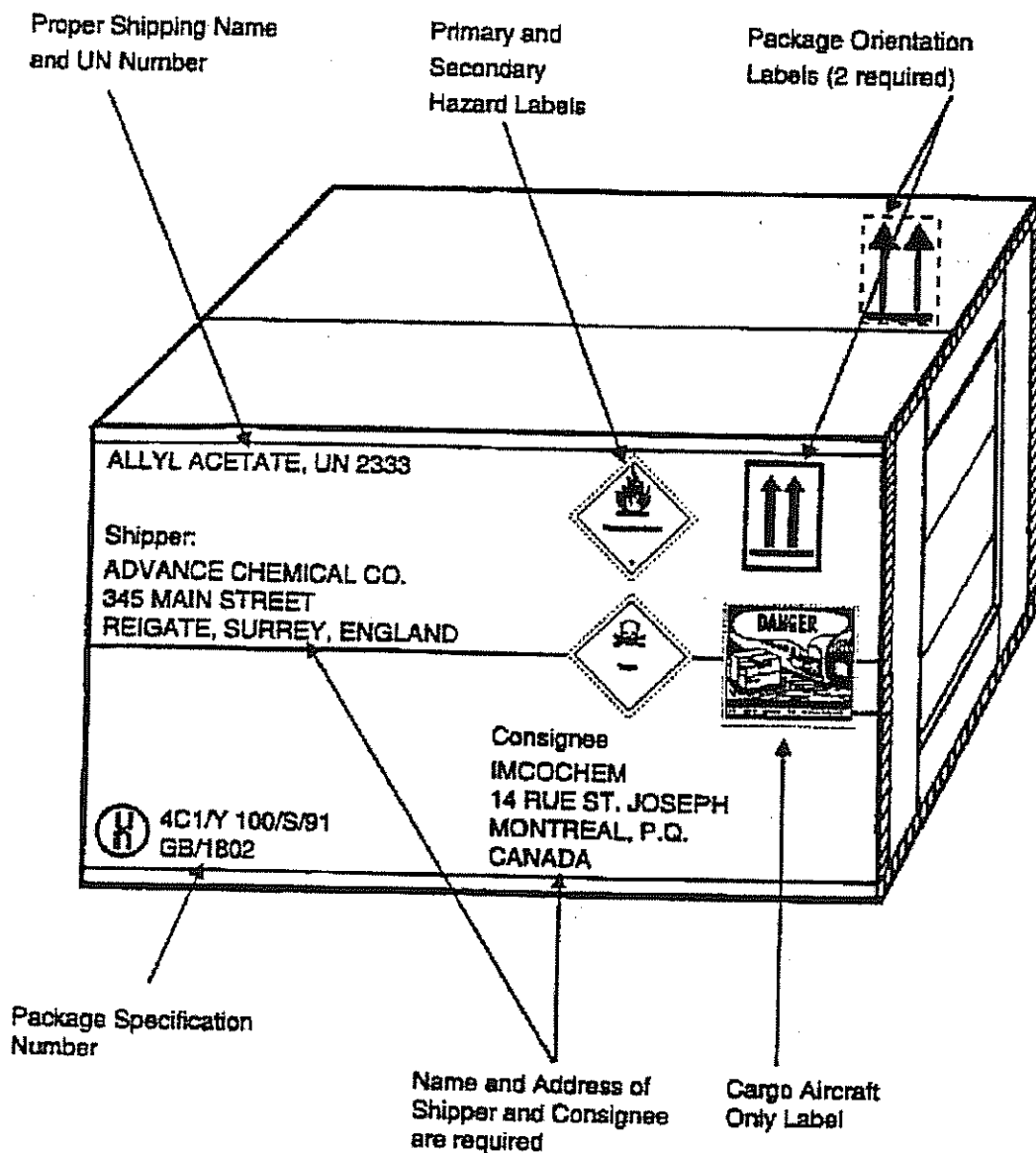
The following potential problems may occur during sample shipment:

- Leaking package. If a package leaks, the carrier may open the package, return the package, and if a dangerous good, inform the Federal Aviation Administration (FAA), which can result in fines.
- Improper labeling and marking of package. If mistakes are made in labeling and marking the package, the carrier will most likely notice the mistakes and return the package to the shipper, thus delaying sample shipment.

- Improper, misspelled, or missing information on the shipper's declaration. The carrier will most likely notice this as well and return the package to the shipper.

Contact the air carrier with questions about dangerous goods shipments and ask for a dangerous goods expert.

FIGURE 1
EXAMPLE OF A CORRECTLY MARKED AND LABELED DANGEROUS GOODS PACKAGE



Source: International Air Transport Association (IATA). 1997.

FIGURE 2
EXAMPLE OF A DANGEROUS GOODS AIRBILL

FedEx Dangerous Goods Airbill **Senders Copy**

13729489 AFFRAN THIS COPY FOR YOUR RECORD

From: **Fill IN** Sender's FedEx Account Number: **1788-8C14-4**

Date: **Fill IN** Phone: **(312) 856 8700**

To: **Fill IN** Company: **TETRA TECH EM INC**

Address: **200 E RANDOLPH ST STE 4700** City: **CHICAGO** State: **IL** Zip: **60601**

City: **CHICAGO** State: **IL** Zip: **60601**

For external Billing Reference: **Fill IN**

To: **Fill IN**

Company: **Fill IN**

Address: **Fill IN**

City: **Fill IN** State: **Fill IN** Zip: **Fill IN**

For HOLD at FedEx Location check here: ☐ Hold Weekday ☐ Hold Saturday

For WEEKEND Delivery check here: ☐ Saturday Delivery ☐ Sunday Delivery

Express Package Service: ☒ FedEx Priority Overnight ☐ FedEx Standard Overnight

Express Freight Service: ☐ FedEx Freight ☐ FedEx Freight

Signature Release: **Unavailable**

Tracking Number: **813350883058** **0204**

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TRANSPORT DETAILS

Point of Departure: **Chicago**

Point of Destination: **"City sending sample to"**

NATURE AND QUANTITY OF DANGEROUS GOODS

Proper Shipping Name	Class or Division	UN or I.D. No.	Packing Group	Subsidiary Risk	Quantity and Type of Packaging	Packing Inst.	Authorization
Flammable liquid, N.O.S.	3	VN 1993	III	—	4 glass jars in a 2A2 steel drum Net Quantity = 4L	309	A3 USG-14

Additional Handling Information: **NAERG# 128 Attached.**

Prepared for AIR TRANSPORT according to: (Customer MUST check one)
☐ 49 CFR ☒ ICAO / IATA

I hereby declare that the contents of this consignment are fully and accurately described above by the proper shipping name and are classified, packaged, marked, and labeled/placarded, and are in all respects in proper condition for transport according to applicable international and national governmental regulations.

Signature: **MB, Environmental Scientist**
Date: **2005 Randolph, Chicago, IL 12/20/01**

Emergency Telephone Number (outside US): **Fill IN** (In US: 800-441-2344)

IF ACCEPTABLE FOR PASSENGER AIRCRAFT THIS SHIPMENT CONTAINS RADIOACTIVE MATERIAL, INTENDED FOR USE IN, OR INCIDENT TO, RESEARCH, MEDICAL DIAGNOSIS, OR TREATMENT.

FIGURE 3

NAERG EMERGENCY RESPONSE INFORMATION
 FOR FLAMMABLE LIQUIDS, N.O.S.

GUIDE 128 FLAMMABLE LIQUIDS (Non-Polar/Water-Insoluble)	NAERG	NAERG	FLAMMABLE LIQUIDS (Non-Polar/Water-Insoluble)	GUIDE 128
POTENTIAL HAZARDS				
FIRE/EXPLOSION • HIGHLY FLAMMABLE: Will be easily ignited by heat, sparks or flames. • Vapors may form explosive mixtures with air. • Vapors may travel to source of ignition and flash back. • No reaction with water at 25°C. They will spread along ground and collect in lower confined areas (sewers, basements, pits). • Under certain conditions, mixtures with air will explode. • Some may polymerize (P) explosively when heated or become in a fire. • Runoff to sewer may create fire or explosion hazard. • Containers may explode when heated. • Materials may be liquid when water. • Containers may be transported full.				
HEALTH • Ingestion: In contact with materials may irritate or burn skin and eyes. • Fire may produce irritating, corrosive and/or asphyxiating gases. • Vapors may cause dizziness or suffocation. • Contact with fire can irritate or burn skin and eyes.				
PUBLIC SAFETY				
• CALL Emergency Response Telephone Number and keep phone open. If being ping, respond as quickly as possible, refer to appropriate telephone number listed on the back of card. • Notify spill or leak area immediately for at least 200 to 300 yards (175 to 260 feet) in all directions. • Keep unauthorized personnel away. • Stay upwind. • Keep out of low areas. • Ventilate closed spaces before entering.				
PROTECTIVE CLOTHING				
• Wear protective gear and self-contained breathing apparatus (SCBA). • Structural firefighting protective clothing will only provide limited protection.				
EVACUATION				
• Large Spill: • Consider initial downwind evacuation for at least 300 meters (1000 feet). • Fire: • If tank, rail car or tank truck is involved in fire, ISOLATE for 150 meters (150 feet) in all directions. Also, consider initial evacuation for 300 meters (300 feet) in all directions.				
EMERGENCY RESPONSE				
FIRE • CAUTION: All those produced with a very low flash point (less than 100°F) may be very flammable. • Fighting fire may be difficult. • Small Fire: • Dry chemical, CO₂, water spray or regular foam. • Large Fire: • Use water spray, fog or regular foam. • Do not use straight stream. • Move containers from fire area if you can do it without risk. • Fire Involving Tanks or Containers: • Fight fire from maximum distance of 300 meters (300 feet) or more, as possible, using water spray. • Cool tanks in situ with fog until gas relief is achieved after fire is out. • Withdraw immediately in case of rising sound from venting on tank due to build-up of back. • ALWAYS stay away from tank in case of fire. • For tanks involved, tank involved may be damaged or even explode. If this is possible, withdraw from area and call fire dept.				
SPILL/LEAK				
• ALL HAZARDOUS materials (including flammable, irritants or corrosives) should be handled with care. • All equipment used when handling the product should be grounded. • Do not touch or walk through spilled material. • Stop work if you cannot do it without risk. • Prevent entry into low areas by fire, fumes, vapors or other gases. • A rapid repressuring hazard may be involved in some cases. • Always wear eye protection when handling or other hazardous materials and wear full protective gear. • Use caution not to inhale fumes or contact absorbed material.				
Large Spill:				
• Call for spill or leak response. • Water spray may reduce vapor; but may not prevent ignition in closed spaces.				
FIRST AID				
• If swallowed: Do not induce vomiting. Call an emergency medical team. • If inhaled: Get fresh air. If water is not available, use moist cloth. • Administer oxygen if breathing is difficult. • Remove and isolate contaminated clothing and shoes. • In case of contact with water, remove contaminated clothing and shoes. • Wash for 15 minutes with water. • Remove contaminated clothing. • Ensure that medical personnel are aware of the material(s) involved, and take precautions as advised by medical personnel.				

Source: DOT and others. 1996.